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An Annotated Bibliography of Thinning Literature

Bryce J. Stokes

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INTRODUCTION

Thinning of both natural and plantation softwood stands has become somewhat of an embattled topic for foresters and scientists. Strong opinion and controversy have surrounded the decision of whether to thin and how to thin. However, most managers are now recognizing that, when properly applied, thinning has a great potential for improving forest holdings.

This bibliography is a general review of thinning, with an emphasis on harvesting in the Southern United States. The bibliography was developed to aid the decision-making process of foresters and as a basis for continued research on thinning of pine stands. Much information is available for the formulation of policies and strategies, as well as for the premises of innovative concepts and ideas. Some silvicultural aspects are included, but these are not intensively reviewed.

References were compiled from many sources. Abstracts and associated information are included for each publication. The citations are displayed in computer fields. Publications are listed alphabetically by primary author, and an index by year, keywords, and author has been included.

Bryce J. Stokes is a research engineer and project leader, Engineering Systems for Intensive Forest Management, U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, Auburn, AL 36849.

1 AUTH Abetz, P.
TITL The European stem-number-experiments in Norway spruce.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 201-206.
YEAR 1969
ABST Position of trees with view to accessibility of harvester and trends in stand growth are given.
KEYW Forecasts, growth and yield, machinery, silviculture

2 AUTH Adamovich, L.L.
TITL Present and planned research and development work on logging techniques in thinnings in North America.
PUBL In: Thinning and mechanization: Proceedings of IUFRO Meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 236-241.
YEAR 1969
ABST Describes research on thinning and lists types of research underway.
KEYW Damage, forecasts, machinery, Northeast, South, systems, West

3 AUTH Adamovich, L.L.
TITL Problems in mechanizing commercial thinnings.
PUBL ASAE Pap. 69-127. St. Joseph, MI: American Society of Agricultural Engineers. 24 p.
YEAR 1968
ABST The reasons for thinning mechanization lagging behind the revolutionary developments that have taken place in the logging industry are given as economic, silvicultural, and technical. It is necessary to compromise between silvicultural methods and mechanization to extend the revolution in operations to intermediate cuttings. Thinning methods are proposed that lend themselves to mechanization. Harvesting efficiency could be increased if conventional uniform thinnings were changed to methods based on systematic layout and changing intensity. The effectiveness of such systematic thinning systems may be evaluated by simulation techniques. Research on mechanics of trees provides useful parameters for machine design and logging technology.
KEYW Cable system, economics, equations, machinery, marking, methods, row thinning, selective thinning, spacing, whole-tree

4 AUTH Adams, T.C.
TITL Production rates in commercial thinning of young-growth Douglas-fir.
PUBL Res. Pap. PNW-41. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 35 p.
YEAR 1967
ABST Time studies were made of the individual steps in the thinning operation, including felling and bucking, skidding, and loading. Calculated times per unit of production were related to log and tree

volumes, in both cubic feet and board feet, and to skidding distance, type of equipment, and other variables. These production rates, combined with labor and machine rates, permit estimation of unit costs related to log size.

KEYW Economics, equations, felling, labor, machinery, processing, skidder, West

5 AUTH Ager, B.H.

TITL On the choice of logging systems for thinning.

PUBL In: Proceedings of XIV IUFRO meeting. 1967 [Month and date unknown]; Munich, Germany. [Place of publication unknown]: [Publisher unknown]: 740-755.

YEAR 1967

ABST Systematical treatment of some factors important to consider in the choice of logging systems for thinning equations.

KEYW Damage, economics, equations, labor, machinery, row thinning, selective thinning, strip thinning, systems

6 AUTH Ager, B.H.

TITL Thinning and mechanization, some views on the research problem and an analysis of harvesting costs.

PUBL In: Thinning and mechanization; Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 2-20.

YEAR 1969

ABST Harvest and future treatment of stands intended for thinning within the next 10 to 15 years are discussed and harvest cost analysis is presented.

KEYW Economics, equations, machinery, selective thinning, shortwood, silviculture, strip thinning, systems

7 AUTH Alig, R.J.; Kurtz, W.B.; Mills, T.J.

TITL Financial return estimates of alternate management strategies for 9- to 15-year-old southern pine plantations in Mississippi.

PUBL Southern Journal of Applied Forestry. 5(1): 3-7.

YEAR 1981

ABST Generally no significant difference in estimated present net worth (based on a 6-percent discount rate) was found between passive management and immediate treatment of southern pine plantations in Mississippi 9 to 15 years old. The immediate management strategy produced considerably larger financial returns only in plantations that contained high hardwood basal areas. Management regimes that delayed treatment until the stand was 30 years old produced lower financial returns than either the passive or immediate treatment regimes. Increases on site index and conifer stocking generally led to higher present net worth for all management strategies.

KEYW Economics, loblolly, plantation, slash pine, South

8 AUTH Alig, R.J.; Mills, T.J.; Shackelford, R.L.

TITL Most soil bank plantings in the South have been retained; some need followup treatments.

PUBL Southern Journal of Applied Forestry. 4(1): 60-64.
YEAR 1980
ABST Report of progress of plots in 91 pine plantations established in 1956-61 as part of the soil bank program in Georgia, Mississippi, and South Carolina.
KEYW Diseases, loblolly, plantation, slash pine, South

9 AUTH Allen, J.F.
TITL The Westvaco thinning system.
PUBL In: Thinning southern pine plantations: Proceedings of southern forest economics workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 87-91.
YEAR 1980
ABST An environmentally sound thinning system for young pine plantations in South Carolina is described. System utilizes a five-man crew, including two chain saw cutters and two portable winch operators.
KEYW Labor, methods, plantation, safety, South, systems

10 AUTH Allen, J.F.; Harmon, M.
TITL Westvaco-Nordfor thinning operation.
PUBL APA Tech. Rel. 79-R-68. Washington, DC: American Pulpwood Association. 6 p.
YEAR 1968
ABST Directional felling, cable skidding, and whole-tree chipping were used in this South Carolina thinning operation. Operation and skidding patterns are also described. There was no damage to the residual stand and there was minimal ground disturbance.
KEYW Biomass, chipping, damage, felling, machinery, methods, site, skidder, training, whole-tree

11 AUTH Anderson, W.C.
TITL Faster thinning with less manpower.
PUBL Southern Lumberman. 231(2872): 75-76.
YEAR 1975
ABST Test of three harvesters (Timber Line TH-100, Cat 950, and Soderhamn) in a slash pine plantation in north Florida on dry sandy soil on flat terrain.
KEYW Harvester, longwood, machinery, plantation, shortwood, slash pine, South, systems, whole-tree

12 AUTH Anderson, W.C.; Granskog, J.E.
TITL Mechanized row-thinning systems in slash pine plantations.
PUBL Res. Pap. SO-103. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 12 p.
YEAR 1974
ABST Machine times and tree measurements were taken on row-thinning operations in slash pine plantations. Equations were developed to estimate productivity of harvesters in shortwood, longwood, and whole-tree systems. Output and costs were calculated for specific stand conditions.

KEYW Economics, equations, felling, harvester, longwood, machinery, plantation, processing, row thinning, shortwood, skidder, slash pine, South, systems, whole-tree

13 AUTH Anderson, W.C.; Guldin, R.W.; Vasievich, J.M.
TITL Assessing the risk of insect attack in plantation investments.
PUBL Journal of Forestry. 85(1): 46-47.
YEAR 1987
ABST Risk of insect attack is discussed as another factor that must be taken into consideration when making investments in forestry rather than in other areas. Monte Carlo simulation is used to quantify the chances of a reasonable return.
KEYW Damage, management, models, South

14 AUTH Andersson, S.O.
TITL Harvesting full trees in thinnings--should the logging residue be removed?
PUBL In: Corcoran, Thomas J.; Gill, Douglas R., eds.Proceedings of COFE/IUFRO conference; 1984 August 11-18; Orono, ME: University of Maine: 241-243.
YEAR 1984
ABST Some companies today are harvesting full trees during thinnings. In a short-term perspective this method offers certain advantages; in the long term, scientists are not sure of the advantage. Sven-Olof Andersson, giving an account here of investigations made by himself and other Nordic scientists, concludes that apparently there is a definite trend. Certain losses of increment of growing stock can be expected if the logging residue is not left on the ground.
KEYW Growth and yield, silviculture

15 AUTH Andersson, S.O.
TITL Row and strip thinning.
PUBL In: Thinning and mechanization; Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 98-107.
YEAR 1969
ABST The advantages and disadvantages are reported of row thinning and stand development after thinning. The distribution of trees by diameter after strip and selective thinning is analyzed.
KEYW Growth and yield, machinery, row thinning, selective thinning, strip thinning

16 AUTH Andrulot, E.R.; Blackwell, L.P.; Burns, P.Y.
TITL Effects of thinning on yield of loblolly pine in central Louisiana.
PUBL Bulletin 6. Ruston, LA: Louisiana Technical University, School of Forestry. 45 p.
YEAR 1979
ABST Individual trees in a 17-year-old natural stand were measured periodically until 47 to 53 years after undergoing one of the following treatments; (a) no thinning, (b) thinning four or five times from 17 to 19 years, and (c) thinning first at 35 to 38 years and, in some cases, several years later. Gross cubic volume yield was not significantly different for any plot or treatment, although net cubic volume yield was

ABST 20 percent higher for thinned stands. This is believed to result from salvage of material that would otherwise have been suppressed. No significant difference between treatments was found in the relative density of wood, although trees in thinned stands grew in diameter and at a more uniform rate than those in the control plots. The form of trees in thinned stands was slightly better than in the unthinned stands.
KEYW Growth and yield, loblolly, methods, natural stand, South

17 AUTH Anonymous
TITL Agricultural tractor and grapple attachment show promise for smallwood extraction.
PUBL [Forest Service Reprint]. Rotorua, New Zealand: New Zealand Industrial Forest Research Institute. [Number of pages unknown].
YEAR 1977
ABST Grapple for agricultural tractor was studied using four methods. Estimates of cost and production rate were developed.
KEYW Economics, machinery, skidder, systems

18 AUTH Anonymous
TITL Looking for profit in production thinning.
PUBL In: Forest Research Institute looks at mechanization. New Zealand Forest Service Reprint. [Date of meeting unknown]; [Place of meeting unknown]. [Place of publication unknown]: [Publisher unknown]: 977.
YEAR 1975
ABST Economics of removing smallwood from final crop stands are presented for two approaches to harvesting thinnings--long-term and short-term. Equipment and methods are discussed and field trials are reviewed.
KEYW Economics, machinery, systems

19 AUTH Anonymous
TITL Mechanized shortwood crew drawn from family members.
PUBL Forest Industries. 109(1): 46-47.
YEAR 1982
ABST System consists of feller-buncher, grapple skidder, and delimber-slasher-loader. An 18-year-old pine stand was thinned for the first time to produce 7,000 cords; average d.b.h. was 7 inches.
KEYW Feller-buncher, harvester, machinery, skidder, strip thinning, systems

20 AUTH Anonymous
TITL Mechanized small-diameter harvesting.
PUBL Southern Lumberman. August; 15: 11-12.
YEAR 1976
ABST A program is described initiated by St. Regis Paper Company to study mechanizing the harvesting of small plantation wood in tree-length form. Goals were: (a) to develop an economical system of mechanical thinning, (b) to research means of thinning mechanically without damage, (c) to investigate the types of equipment and number of people necessary, and (d) to discover the cost-productivity of such a system.
KEYW Damage, economics, plantation, South, systems, whole-tree

21 AUTH Anonymous
TITL Needed: A peewee yarder.
PUBL [Leaflet]. Portland, OR: U.S. Department of Agriculture, Forest Service; Pacific Northwest Forest and Range Experiment Station. [Not paged].
YEAR 1976
ABST A small, highly portable yarder is described that can be used to thin young timber stands on steep slopes.
KEYW Cable system, damage, steep slopes

22 AUTH Anonymous
TITL New method for the conversion of softwood during first and second thinning operations.
PUBL Allgemeine Forstzeitschrift. 7: 136.
YEAR 1985
ABST Descriptions are given of the Jackle extraction equipment (JAVO), a hydraulic winch system designed to mount on a 60-horsepower agricultural tractor, and the Jackle small processor (JAPRO), a trimmer/cross cutter designed for mounting on a 90-horsepower agricultural tractor. Operating cost and production rates are given for the machine.
KEYW Cable system, economics, equipment, skidder

23 AUTH Anonymous
TITL New system for harvesting pulpwood.
PUBL Forest Industries. 100(12): 117.
YEAR 1973
ABST In this description of the Morbark total chip harvester system, little crown damage to stand, no high stumps, and no residual tops or slash are reported. Production was 250 to 300 tons of chips in 6 hours.
KEYW Chipping, feller-buncher, machinery, selective thinning, systems, whole-tree

24 AUTH Anonymous
TITL Pulpwood dealer, plantation owners approve harvester.
PUBL Pulpwood Production and Timber Harvesting. 10: 17,20,24.
YEAR 1974
ABST The Timberjack RW-30 exceeded expectations by yielding more than conventional cutting methods. The three-man crew averaged 25 cords per day.
KEYW Economics, harvester, machinery, plantation, pulpwood, systems, volumes

25 AUTH Anonymous
TITL Row thinning--some guidelines.
PUBL Forest Farmer. 3(13): 6-7.
YEAR 1971
ABST Because economic factors and labor shortages in the woods now dictate economics of harvesting methods, they form a new and key variable in the decision-making process causing the current trend toward mechanization, incorporating faster processes in harvesting wood products and dispatching them to sites of primary manufacture. The task force agrees that individual tree selection is silviculturally the best method of

thinning but, believing it will be uneconomical in many areas of the South, recommends row thinning for most cases now and in the future. Row thinning is economical because it makes mechanical harvesting possible. Because of unprecedented tree planting reports in the South since 1950, more than 1 million acres of pine plantations will reach thinning age each year--starting now. As a result, all but small landowners will be forced to select some sort of row thinning for economic reasons.

KEYW Economics, machinery, row thinning

26 AUTH Anonymous
TITL The second time around Burrow Logging Company made thinning work.
PUBL Timber Harvesting. 34(12): 42-43.
YEAR 1986
ABST Equipment used in plantation thinning is described.
KEYW Feller-buncher, skidder

27 AUTH Anonymous
TITL Small wood--small machines.
PUBL [Newsletter]. 5(6). Rotorua, New Zealand: Logging Industry Research Association. [Not paged].
YEAR 1980
ABST Two machines from New Zealand: Bell infield logger (three wheeler and overhead grapple) and Iwate Fuji T20 skidder (a four-wheel-drive, articulated steering, rubber-tired skidder with double-drum winch and log-loading forks) are described. Advantages of the Bell three wheeler are maneuverability and versatility; the disadvantage is a lack of traction on slopes greater than 10 degrees and on wet soils. Traction may improve with chains. Fuji T-20 has good traction, maneuverability, and versatility. Both machines are good alternatives for small timber.
KEYW Machinery, skidder, steep slopes

28 AUTH Anonymous
TITL Thinning southern pine.
PUBL The Logger and Lumberman. 25(6): 6-7.
YEAR 1986
ABST Different aspects of southern pine thinning are presented.
KEYW Growth and yield, methods, spacing

29 AUTH Anonymous
TITL Two-man crew moves 200 cords per week.
PUBL Forest Industries. 105(7): S-1, S-2.
YEAR 1978
ABST Two-man crew uses one Melroe Bobcat with a 16-inch shear, Clark 666 grapple skidder, a shop-built delimbing gate, and Barko 140 hydraulic loader. Hauling was contracted with truck drivers doing the loading.
KEYW Machinery, systems

30 AUTH Arola, R.A.; Hillstrom, W.A.
TITL Mechanical thinning of northern hardwoods.

PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST Experiments in mechanical thinning of pole size northern hardwoods have demonstrated about 50 green tons per acre can be recovered at a loss of about $11.50 per ton. Early evaluations show this damage is acceptable. It appears that energy requirements may provide the needed market for green chips.
KEYW Chipping, damage, economics, growth and yield, machinery, models

31 AUTH Arvidsson, A.
TITL Thinning, a financial affair.
PUBL APA Tech. Pap. 80-P-5. Washington, DC: American Pulpwood Association. [Number of pages unknown].
YEAR 1980
ABST Author deals with some fundamental rules and facts of silviculture in Scandinavia.
KEYW Economics, felling, machinery, precommercial thinning, silviculture

32 AUTH Arvidsson, A.; Knutell, H.
TITL Mechanized felling in thinnings under winter conditions.
PUBL Res. Note 120. Garpenberg, Sweden: Department of Operational Efficiency, Royal College of Forestry. 2 p.
YEAR 1977
ABST The effects of winter conditions on mechanized felling in thinnings are investigated. The factors studied were: time consumption, selection (thinning quality), damage to the remaining stand, and stump height.
KEYW Damage, machinery, row thinning, selective thinning

33 AUTH Ashmore, C.; Stokes, B.J.; Izlar, B.
TITL Lokoma cone saw felling heads.
PUBL APA Tech. Rel. 84-R-38. Washington, DC: American Pulpwood Association. 2 p.
YEAR 1984
ABST The Lokoma cone saws are unique new felling heads developed and manufactured by Rauma-Repola Oy of Finland and marketed in the United States by Forrex, Inc., in Jackson, MS. The saw blades are tapered involute cones that advance into the trees when the blade is rotated on its turntable. The cut of the saws is perpendicular to the shaft of the tree near groundline. This sawing action prevents common butt shatter that can be caused by conventional shears. Because the saw's singular revolution occurs only while cutting, there are no inertial imbalances during swing or dumping.
KEYW Felling

34 AUTH Ashmore, C.; Stokes, B.J.; Lanford, B.L.
TITL Thinning performance of the Hydro-Ax 411 in fifth-row removal.
PUBL ASAE Pap. 83-1604. Presented at the winter meeting of the American Society of Agricultural Engineers; 1983 December 13-16; Chicago, IL. St. Joseph, MI: American Society of Agricultural Engineers. 19 p.

YEAR 1983
ABST The Hydro-Ax 411 with the 41-centimeter (16-inch) high-speed feller-buncher head was evaluated as a first-pass felling machine for removing corridor rows in a row-select thinning operation. Prediction equations were developed on a time-per-tree basis for position and shear, move-to-tree, and move-to-dump, and dump. The estimated cost for felling and bunching trees from the corridor row was $2.89 per cubic meters ($8.22 per cunit).
KEYW Feller-buncher, machinery, plantation, row thinning, selective thinning, silviculture

35 AUTH Aulerich, E.D.; Peters, P.A.; Sedlack, S.P.
TITL Thinning with the Kollar multispan carriage.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide. Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST An Austrian multispan carriage manufactured by Koller Kufstein was used with intermediate supports to thin Douglas-fir. Data were gathered on the tension developed in the skyline and support cables, and production data were gathered for evaluation of the feasibility of thinning with multispans.
KEYW Cable system, economics, whole-tree

36 AUTH Axelsson, J.; Eriksson, L.
TITL Estimation of thinning--computerized simulation of biological and economic effects of different thinning methods.
PUBL Rep. 166. Garpenberg, Sweden: Swedish University of Agricultural Science, Department of Operational Efficiency. 7 p.
YEAR 1986
ABST The computerized simulation of biological and economic effects resulting from different types of thinnings are reported, with a discussion of the results.
KEYW Economics, volumes

37 AUTH Bailey, R.L.; Abernathy, N.C.; Jones, E.P., Jr.
TITL Diameter distribution models of repeatedly thinned slash pine plantation.
PUBL In: Barnett, James P., ed. Proceedings of the first biennial southern silvicultural research conference; 1980 November 6-7; Atlanta, GA. Gen. Tech. Rep. SO-34. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 115-126.
YEAR 1981
ABST Results of an effort to determine if traditional diameter distribution methods of modeling can be applied to repeatedly thinned pine plantations are reported. Data are from 297 plots in slash pine plantations thinned and remeasured up to five times over a period of about 20 years. The Weibull distribution fitted diameter distributions quite well--as well as it and other distributions have fitted data from unthinned stands. Models were developed to predict and project the 24th, 63rd, and 93rd percentiles of distributions for unthinned stands, stands after first thinning, and following a growth period of variable

length. An analysis of distributions before and after thinning showed no differences except at the first thinning. The first thinning, primarily a thinning from below, tended to shift the distribution toward large trees (more negative skewness). An example shows the models applied to project the distributions before and after thinning at ages 15, 20, and 25, and final distribution at age 30.

KEYW Equations, models, plantation, slash pine, South

38 AUTH Baker, J.B.

TITL The Crossett Farm Forestry Forties after 41 years of selection management.

PUBL Southern Journal of Applied Forestry. 10: 233-236.

YEAR 1986

ABST Timber management was initiated in 1937 to determine whether selection management could be used to rehabilitate understocked loblolly-shortleaf pine stands while providing an income to the landowner. Results of this experiment are reported.

KEYW Hardwood, loblolly, management

39 AUTH Baker, J.B.; Cain, M.D.

TITL Precommercial thinning of pine regeneration in uneven-aged stands.

PUBL Res. Pap. SO-1117. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 17 p.

YEAR 1980

ABST Study of precommercial thinning of understory pine to determine extent of effects, if any, on growth of overstory pine in natural stands.

KEYW Growth and yield, natural stand, precommercial thinning, selective thinning

40 AUTH Ballard, R.; Duzan, H.W. Jr.; Kane, M.B.

TITL Thinning and fertilization of loblolly pine plantations.

PUBL In: Barnett, James P., ed. Proceedings of the first biennial southern silvicultural research conference; 1980 November 6-7; Atlanta, GA. Gen. Tech. Rep. SO-34. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 100-104.

YEAR 1981

ABST Over a 4-year period gross volume response to nitrogen fertilization in 12 loblolly pine plantations averaged 197 cubic feet per acre for thinned areas and 157 cubic feet per acre for unthinned areas. The greater fertilizer response advantage in thinned stands was more pronounced and consistent when assessed in terms of net volume, sawlog volume, and mean diameter. Periodic volume responses to thinning and fertilization are modelled in terms of stand and site variables.

KEYW Equations, fertilization, growth and yield, loblolly, models, plantation, South

41 AUTH Balmer, W.E.; Utz, K.A.; Langdon, O.G.

TITL Financial returns from cultural work in natural loblolly pine stands.

PUBL Southern Journal of Applied Forestry. 2(4): 111-117.

YEAR 1978

ABST Yields from naturally regenerated stands of loblolly in Virginia and North Carolina were compared under different cultural treatments. In one study there were three treatments, A, B, and C, of 37-acre areas: A = control burning before harvest, B = A + controlling hardwoods with d.b.h. of 5 inches or more, and C = A + B + precommercial thinning of pine at 6 years and removal of small broadleaves. In a second study, the plots under treatment C in the first study were further thinned at 7 to 8 years to give 288 to 540 pines per acre, and at 14 years, basal area was reduced to 60 to 100 square feet per acre. All small broadleaves were removed on half of these plots. Pine production and financial returns increased progressively with intensity of treatment: under treatment C, yields were three and four to six times greater than under treatments A and B respectively. Under the second study, when all hardwoods were controlled from an early age, the yield (financial return) was more than double the returns from the other treatments.
KEYW Economics, growth and yield, loblolly

42 AUTH Balmer, W.E.; Williston, H.L.
TITL The need for precommercial thinning.
PUBL [Forest Management Bulletin]. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southeastern Area, State and Private Forestry. 6 p.
YEAR 1973
ABST Discussion of the importance of stocking level and various methods of achieving a desired level.
KEYW Machinery

43 AUTH Barclay, H.J.; Pang, P.C.; Pollard, D.F.W.
TITL Aboveground biomass distribution within trees and stands in thinned and fertilized Douglas-fir.
PUBL Canadian Journal of Forest Research. 16(3): 438-442.
YEAR 1986
ABST Nine years after heavy thinning and fertilization with Urea, 34-year-old Douglas-firs were destructively sampled. Dry weights of seven components aboveground (wood, bark, dead branches, new or old foliage, new twigs, and live branches) were determined and regression equations from d.b.h. were developed. Thinning reduced the proportion of wood, bark, and dead branches. Fertilization increased the proportion of branches but had negligible effect on the proportions of other components.
KEYW Fertilization

44 AUTH Barnes, R.L.
TITL Growth and yield of slash pine plantations in Florida.
PUBL Res. Pap. 3. Gainesville, FL: University of Florida, School of Forestry. 3 p.
YEAR 1955
ABST A study was undertaken to establish relationships of growth and yield to age, spacing, and site quality, for planted slash pine in Florida. Methods of determining site quality for slash pine plantations are described, and growth and yield data are presented.
KEYW Growth and yield, plantation, site, slash pine, South, spacing

45 AUTH Barrett, J.W.
TITL Thinning east of the Cascades--opportunities, tree response, methods, equipment, and costs.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST Current thinning practices in eastern Oregon and Washington are summarized for those unfamiliar with Pacific Northwest thinning and slash disposal practices. The potential land base for thinning, old growth harvesting necessary before thinning, the response of different species to precommercial and commercial thinning, density regulation, slash disposal, and associated costs involved in these operations are several of the topics that are addressed.
KEYW Diseases, economics, precommercial thinning, West

46 AUTH Baskerville, G.L.
TITL Silviculture, logging, and money.
PUBL Pulp and Paper Magazine of Canada. 67(2): WR49-WR50.
YEAR 1966
ABST The author reports that not only the value of increased wood production, traditionally considered, but also savings in harvesting costs should be considered as part of the return on silvicultural investment.
KEYW Economics, silviculture

47 AUTH Bassett, J.R.
TITL Growth of widely spaced loblolly pine.
PUBL Journal of Forestry. 67(9): 634-636.
YEAR 1969
ABST At age 21, plots of loblolly pine thinned to 10 square feet of basal area at age 9 yielded a total of 88 cubic feet per acre per year. They supported 76 trees per acre averaging 12.9 inches d.b.h. and containing 6,400 board feet of sawtimber. Plots thinned to 85 square feet of basal area cubic feet per acre per year. They supported 251 trees per acre averaging 7.8 inches d.b.h. and containing 300 board feet of sawtimber. Thinning did not affect height growth, form class, or wood specific gravity.
KEYW Growth and yield, loblolly, South, spacing

48 AUTH Bassett, J.R.
TITL Seasonal diameter growth of loblolly pines.
PUBL Journal of Forestry. 64(10): 674-676.
YEAR 1966
ABST From 1960 through 1964, seasonal diameter growth of 30-year-old loblolly pine stands, thinned to 55, 80, and 125 square feet of basal area per acre, were recorded on loessial soils in southeast Arkansas (site 90 to 100). These pines completed 53 percent of their annual growth by May 31, and 68 percent by July 15. In dry years proportionately more growth occurred by these dates than in wet years. Dominants and codominants

grew longer and faster in lightly stocked stands than in heavily stocked stands.
KEYW Growth and yield, loblolly, site, South

49 AUTH Baumgras, J.E.
TITL Predicting product yields from thinnings in Appalachian hardwoods.
PUBL Journal of Forestry. 82(1): 43-46.
YEAR 1984
ABST Fifty to 70-year-old stands of mixed hardwood in Virginia and West Virginia were thinned, and product volumes of trees 5 inches or greater in d.b.h. were measured for 113 plots in 17 stands using multiple regression, volumes per acre of sawlogs, sawbolts, pulpwood, and fuel.
KEYW Hardwood, Northeast, volumes

50 AUTH Beers, T.W.
TITL Components of forest growth.
PUBL Journal of Forestry. 60(4): 245-248.
YEAR 1962
ABST Discussion of the use of continuous forest inventory and all components of forest growth including formulas for the calculation of growth.
KEYW Growth and yield

51 AUTH Bella, I.E.
TITL A new competition model for individual trees.
PUBL Forest Science. 17(3): 364-372.
YEAR 1971
ABST The model represents mathematically competitive interaction between individual trees. It consists of two basic components: (1) the influence zone of each tree (which is a function of its size), and (2) the amount and nature of interaction (which depends on the distance between and relative size of the competing tree and its competitors and also on a power of relative tree sizes). Optimum model parameters were obtained by interactive procedures on a computer, combined with regression analyses for pure, even-aged, fully stocked stands of Douglas-fir, jack pine, red pine, aspen, and for an even-aged stand of eucalyptus growing at a range of stand densities. The model satisfactorily described competition effect for the five stands studied and accounted for a greater portion of variation in tree growth than some of the earlier competition indices.
KEYW Equations, growth and yield, models, West

52 AUTH Bennecke, K.
TITL Whole tree harvesting in young Norway spruce stands.
PUBL Allgemeine Forstzeitschrift. 19: 464.
YEAR 1985
ABST A cable line-thinning method was used in a 46-year-old stand (partly accessible by road) and a 38-year-old stand (on a steep slope). Operating cost and production information are included.
KEYW Cable system, economics, equipment, steep slopes

53 AUTH Bennett, F.A.
TITL Growth and yield of slash pine plantations.
PUBL Res. Pap. SE-1. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 23 p.
YEAR 1963
ABST Although slash pine has the most limited range of the major southern pines, more has been planted than any other southern pine. Because most of this planting is recent, information on the growth and yield has been lacking. The purpose of this paper was to summarize information on slash pine growth and yield.
KEYW Growth and yield, plantation, slash pine, South

54 AUTH Bennett, F.A.
TITL Growth and yield research with application in the field of thinning and mechanization.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 207-216.
YEAR 1969
ABST Evaluation of the relationships of growth and total yield, expressed in various product forms, to age, site index, and stand density.
KEYW Equations, growth and yield, hardwood, loblolly, longleaf, machinery, plantation, processor, slash pine, South, spacing, volumes

55 AUTH Bennett, F.A.
TITL How should pine plantations be thinned?
PUBL Forest Farmer. June 1971: [Page number unknown].
YEAR 1971
ABST Consideration of thinning methods from several stand points suggests that the grower who has a specific product objective should choose a spacing tailored to his needs and not rely on intermediate thinnings as a primary means of developing the product.
KEYW Methods, plantation, pulpwood, spacing

56 AUTH Bennett, F.A.
TITL International 1/4-inch board-foot volume tables for old-field slash pine plantations in the middle coastal plain of Georgia.
PUBL Res. Note 126. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 2 p.
YEAR 1959
ABST International 1/4-inch board-foot volume tables are presented for use in old-field slash pine plantations in the middle coastal plain of Georgia. The increasing number of plantations reaching sawtimber size in this region emphasizes the need for such tables.
KEYW Plantation, slash pine, South, volumes

57 AUTH Bennett, F.A.
TITL The role of thinning and some other problems in management of slash pine plantations.
PUBL Res. Pap. SE-86. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 14 p.
YEAR 1971

ABST In the management of slash pine plantations, the role of thinning is changing from its traditional use as a silvicultural tool developed for natural stands. For pulpwood production, many owners are selecting spacings that will not require thinning during the rotation. Others insist that thinning must be financially advantageous even in pulpwood rotations by yielding an early recovery of establishment costs. Length of rotation, as related to growth rates, is also a point in question, and early liquidation may be a temptation to those unaware of production rates at various ages. To help solve some of these problems, production figures at yearly intervals for unthinned slash pine plantations are outlined here, as the possible effect of thinning on growth, and the role of thinning in the management of these plantings is evaluated.
KEYW Growth and yield, plantation, slash pine, South, spacing

58 AUTH Bennett, F.A.
TITL Spacing and early growth of planted slash pine.
PUBL Journal of Forestry. 58(12): 966-967.
YEAR 1960
ABST The age at which competition begins in slash pine plantations is one of the factors that influences the forest manager in his spacing decision. The slash pine spacing study, reported in this paper and conducted on the George Walton Experimental Forest, Dooly County, GA, establishes relationships between plantation spacing and competition. A secondary feature is the comparison of square and rectangular spacings.
KEYW Growth and yield, plantation, slash pine, South, spacing

59 AUTH Bennett, F.A.
TITL Thinning slash pine.
PUBL In: A guide to loblolly and slash pine plantation management in Southeastern U.S. Macon, GA: Georgia Forestry Research Council: 111-116.
YEAR 1965
ABST A thinning is a cutting made in an immature stand to increase the growth of the residuals and the total production of the stand. Clearings, improvement cuttings, and salvage cuttings are considered separate and distinct silvicultural operations. However, the first thinning in a plantation will probably be a combination of the various intermediate cuttings. In discussing thinning, the author bears in mind that, although thinning objectives will dominate, they will not exclude aims of the improvement cut and the salvage cut because these also contribute to good management and good silviculture.
KEYW Diseases, plantation, silviculture, slash pine, South, spacing

60 AUTH Bennett, F.A.
TITL Yields and stand structural patterns for old-field plantations of slash pine.
PUBL Res. Pap. SE-60. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 81 p.
YEAR 1970
ABST Yield estimates for slash pine plantations have been available since 1955, but they do not provide detailed information on stand structure as influenced by age, site, and stand density. For example, all the yield studies presented here indicate an almost continuous increase in

cordwood volume as number of trees per acre is increased, but give little information on tree sizes (other than average d.b.h.), or the number of trees that may be below the minimum merchantable size at given ages. Increased yields from the denser stands may be more than offset by the increased cost of harvesting the smaller tree sizes. Some logging cost records indicate 5- and 6-inch trees are submarginal, or at best marginal. Some knowledge on diameter ranges in these plantations would be invaluable in management programing.

KEYW Growth and yield, multiproduct, plantation, slash pine, South

61 AUTH Bennett, F.A.; Clutter, J.L.

TITL Multiple-product yield estimates for unthinned slash pine plantations--pulpwood, sawtimber, gum.

PUBL Res. Pap. SE-35. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 21 p.

YEAR 1968

ABST Optimal growing space depends upon management objectives and financial policy. Although the amount and distribution of growing stock can be controlled through planting, management may be ineffective without information on multiple-product yields. Wide spacing is needed in slash pine stands for optimal sawtimber and gum yields, whereas close spacing is necessary to maximize pulpwood yields. However, if the objective of management is to maximize returns in dollars and cents, some compromise may be required between the two extremes. Optimal density and rotation age for predicting multiple-product yields are determined for combinations of plantation age, site index, and stand density; and yield tables were developed for old-field, unthinned pine plantations.

KEYW Equations, growth and yield, multiproduct, plantation, pulpwood, slash pine, South, spacing

62 AUTH Bennett, F.A.; Lloyd, F.T.; Swindel, B.F.; Whitehorne, E.W.

TITL Yields of veneer and associated products from unthinned, old-field plantations of slash pine in the north Florida and south Georgia flatwoods.

PUBL Res. Pap. SE-176. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 80 p.

YEAR 1978

ABST Mixed yields of veneer, pulpwood, studs (from veneer cores), and chips are predicted for unthinned, old-field plantations of slash pine in the south Georgia and north Florida flatwoods. Data on stand area and stand age, an estimate of site index, and the present number of trees per acre are required to make predictions. The yield model used here allows specification of the minimum scaling diameter (inside bark) for peeler blocks, the top diameter (outside bark) merchantability limit, the average stump height, the average trim allowed when cutting peeler blocks, and the minimum number of blocks (usually equal to one) for a tree to be considered merchantable for veneer. However, only a single set of utilization standards are used in the yield table presented. Pulpwood volume comes from veneer-tree topwood and from merchantable (5 inches or larger at breast height) nonveneer trees. Since all yields are broken down by diameter classes, quality assessment is possible.

KEYW Growth and yield, multiproduct, plantation, slash pine, South

63 AUTH Bennett, F.A.; McGee, C.E.; Clutter, J.L.
TITL Yield of old-field slash pine plantations.
PUBL Pap. 107. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 19 p.
YEAR 1959
ABST Yields are given of plots of design, a randomized complete block with two replications in each field. Plot size was approximately 1/4 acre in the larger field and 1/5 acre in the smaller field.
KEYW Equations, growth and yield, natural stand, precommercial thinning, slash pine, South, spacing

64 AUTH Blonsky, J.E.
TITL Power tine grapple.
PUBL [Harvesting Research Project]. Washington, DC: American Pulpwood Association. 21 p.
YEAR 1970
ABST Provides a description of the research, development, design, testing, and manufacturability of the power tine grapple developed to reduce the manual labor and production costs associated with the harvesting of small diameter pulpwood trees on small volume tracts and to improve the safety of harvesting operations. The grapple is designed for quick attachment to the standard three-point hitch of farm tractors. The tractor-mounted, hydraulically operated grapple performs the functions of grasping, raising, and skidding bundles of small trees to a suitable location for further processing. Use of this grapple can solve many problems with small wood harvesting. It eliminates the intensive manual labor required to attach chokers or chains to individual trees. In addition, it does not require wire rope and chain chokers, which are often overloaded and become hazardous.
KEYW Economics, labor, machinery, pulpwood, skidder

65 AUTH Bonicelli, B.; Bonnafous, J.C.; Villeger, A.
TITL A robot arm for forest thinning.
PUBL Agrotique. [Vol. unknown]: 37-45.
YEAR 1986
ABST Details are given of the French Bref Programme to develop a thinning robot; an automatic feller-buncher which consists of a special forest tractor equipped with a robot arm.
KEYW Feller-buncher, machinery

66 AUTH Bower, D.R.
TITL Volume-weight relationships for loblolly pine sawlogs.
PUBL Journal of Forestry. 60(6): 411-412.
YEAR 1962
ABST Regression equations are determined for tree volumes and truckload volumes.
KEYW Loblolly, South, volumes

67 AUTH Boyette, W.G.; Brenneman, D.L.
TITL Thinning and fertilization in a 25-year-old natural upland hardwood stand in the southern Appalachians--5-year results.
PUBL Forestry Note 48. Raleigh, NC: North Carolina Forest Service, Division of Forest Resource. 5 p.
YEAR 1981
ABST Initial tree diameter was the most important influence on tree growth response to thinning and fertilization in a 25-year-old natural stand of upland hardwoods. After adjustment between treatments for unequal initial tree diameters, the growth in d.b.h., basal area, and especially volume was seen to respond to fertilizer treatment, while thinning gave no better volume growth than no treatment, although it did give better d.b.h. and basal area growth. Thinning produced less growth in height than fertilization. Neither treatment is feasible in pole-sized upland hardwood stands on marginal sites.
KEYW Fertilization, growth and yield, hardwood, natural stand, site

68 AUTH Brender, E.V.; Clutter, J.L.
TITLE Yield of even-aged natural stands of loblolly pine.
PUBL Rep. 23. Macon, GA: Georgia Forestry Research Council. 7 p.
YEAR 1970
ABST Growth and yield data of 179 even-aged loblolly pine stands were gathered over a 22-year period. The data collected were analyzed by a least squares regression procedure developed by A. D. Sullivan. Yields were projected for natural stands of loblolly with initial age 20, 30, or 40. Per acre volume was also calculated for stands at age 20.
KEYW Growth and yield, loblolly, natural stand, South

69 AUTH Brender, E.V.; McNab, W.H.
TITL Precommercial thinning of loblolly pine by fertilization.
PUBL Res. Pap. 90. Macon, GA: Georgia Forestry Research Council. 7 p.
YEAR 1978
ABST An investigation of the effect of fertilization upon natural thinning and diameter, recording growth of dominant and codominant trees in a 19-year-old loblolly pine stand in Georgia. Heavy fertilization (nitrogen 230 pounds per acre; phosphorus 3.5 pounds per acre) increased mortality of suppressed trees over 2 to 3 years and improved the growth of the better trees. The authors suggest that periodic applications of fertilizer could maintain accelerated growth of the upper canopy while increasing mortality of the lower canopy.
KEYW Fertilization, growth and yield, loblolly, methods, precommercial thinning

70 AUTH Broderick, S.H.; Thurmes, J.F.; Klemperer, W.D.
TITL Economic evaluation of old-field pine plantation management alternatives.
PUBL Southern Journal of Applied Forestry. 6(1): 9-15.
YEAR 1982
ABST A revised version of a plantation simulator was used with data from Virginia to maximize the net present value (at planting date) given different product mixes and prices, interest rates, spacings, harvest ages; and intensity, frequency, and timing of thinnings. Inflation was excluded from the model, and the alternate rate of return was used as a

discount rate. Results indicated that economically operated management should include spacings greater than 6 by 6 or 6 by 8 feet; for pulpwood production, clear felling at 20 years with no thinning; and, for harvesting pulpwood, sawlogs, and peelers, thinning to about 33-percent volume at 15 years with clear felling after 30 years.

KEYW Economics, loblolly, plantation, systems

71 AUTH Brown, J.E.
TITL New silvicide proves potent for thinning dense stands.
PUBL Pulp and Paper Magazine of Canada. July; 3: 77-79.
YEAR 1970
ABST A silvicide, cacodylic acid, and a hatchet injector as a means of applying the chemical were tested on 11 eastern Canadian tree species. The combination was found to be an effective means of thinning dense young stands.
KEYW Chemicals, precommercial thinning

72 AUTH Brown, M.W.; Nebeker, T.E.; Honea, C.R.
TITL Thinning increases loblolly pine vigor and resistance to bark beetles.
PUBL Southern Journal of Applied Forestry. 11(1): 28-31.
YEAR 1987
ABST Changes of growth in height and diameter, and of oleoresin exudation pressure are presented for the first 3 years following thinning. Introducing southern pine beetles into the plots resulted in a significantly lower proportion of successful attacks in thinned plots in the first 2 years following thinning. It was concluded that increased tree vigor, along with the increase in tree spacing following thinning, reduces susceptibility to southern pine beetle attack when stands are thinned to a basal area of 100 square feet per acre or less.
KEYW Diseases

73 AUTH Bryan, R.W.
TITL Planting machine expanding horizons.
PUBL Forest Industries. 97(10): 46-47.
YEAR 1970
ABST A description is given of general operating characteristics of a Franklin feller-buncher equipped with a V-shaped bunk.
KEYW Feller-buncher

74 AUTH Bryan, R.W.
TITL Prehaulers enable pulpwood producer to get out volume in plantation thinning.
PUBL Forest Industries. 103(3): 88-89.
YEAR 1976
ABST Account of the use of Soderhamn hydraulic-grapple forwarders by a small logging enterprise in Louisiana, during row thinnings in slash pine, including notes on a successful system of labor management on a piece-work basis.
KEYW Labor, machinery, pulpwood, row thinning, shortwood, South, systems

75 AUTH Bullard, S.H.; Klemperer, W.D.
TITL Thinning optimization for mixed-species forests.
PUBL In: New forests for a changing world: Proceedings of the 1983 Convention of the Society of American Foresters; 1983 October 16-20; Portland, OR. Bethesda, MD: Society of American Foresters. [Number of pages unknown].
YEAR 1983
ABST An approach is summarized for estimating optimal thinning and final harvest age for existing, mixed-species stands. The method involves stand-table projection with upgrowth and mortality equations, formulated as an integer-nonlinear programming problem. Random search methods are proposed for estimating optimal cutting prescriptions. Such solution methods warrant further study in forestry, because their use enables broad application of stand-specific modeling results.
KEYW Growth and yield, models

76 AUTH Bullard, S.H.; Sherali, H.D.; Klemperer, W.D.
TITL Estimating optimal thinning and rotation for mixed-species timber stands using a random search algorithm.
PUBL Forest Science. 31(2): 303-315.
YEAR 1985
ABST The problem of optimal density over time for even-aged, mixed-species stands is formulated as a nonlinear-integer programming problem with numbers of trees cut by species and diameter class as decision variables. The model is formulated using a stand-table projection growth model to predict mixed-species growth and stand-structure. Optimal solutions are estimated for problems with eight initial species/diameter class groups, projected for up to three discrete growth periods.
KEYW Growth and yield, models

77 AUTH Burkhart, H.E.; Cloeren, D.C.; Amateis, R.L.
TITL Yield relationships in unthinned loblolly pine plantations on cutover, site-prepared lands.
PUBL Southern Journal of Applied Forestry. 9(2): 84-91.
YEAR 1985
ABST Data were collected in unthinned loblolly pine plantations across much of the South. Regression relationships were developed between yield of planted loblolly pine and measurements of the planted pine and competing vegetation. The relationships of yield and site preparation methods to physiographic regions were assessed. These analyses showed that the yield of the planted pine component could be predicted adequately from age, average height of dominant and codominant trees, and number of surviving planted trees per unit area.
KEYW Growth and yield, loblolly, site

78 AUTH Burkhart, H.E.; Haney, H.L., Jr.; Newberry, J.D.; Leuschner, W.A.; Morris, C.L.; Reed, D.D.
TITL Evaluation of thinning for reduction of losses from southern pine beetle attack in loblolly pine stands.
PUBL Southern Journal of Applied Forestry. 10(2): 105-108.

YEAR 1986
ABST Previously published models for growth and yield of loblolly pine and probability of infestation by southern pine beetle were used to compute expected volume losses for three site indices, three sizes of beetle population and four thinning regimes. An economic analysis is presented of the losses prevented by thinning. Results showed that thinning can be expected to reduce losses on average and better sites.
KEYW Damage, growth and yield, loblolly

79 AUTH Burkhart, H.E.; Sprinz, P.T.
TITL Compatible cubic volume and basal area projection equations for thinned old-field loblolly pine plantations.
PUBL Forest Science. 30(1): 86-93.
YEAR 1984
ABST Compatible equations for predicting cubic volume and basal area growth were developed by simultaneously estimating the coefficients in both models. The simultaneous estimation procedure gave stable estimates for the basal area projection equation regardless of the merchantability definitions imposed in the volume projection equation. Prediction equations were fitted using the simultaneous estimation procedure with growth data from thinned loblolly pine plantations established on old-field sites in the Piedmont and coastal plain of Virginia.
KEYW Growth and yield, loblolly, models, plantation, South, volumes

80 AUTH Burrows, J.O.; Olsen, E.D.; Kellog, L.D.
TITL Swinging and processing whole trees in a Douglas-fir thinning.
PUBL Transactions of the ASAE. St. Joseph, MI: American Society of Agricultural Engineers. 29(1): 31-33.
YEAR 1986
ABST Procedures, crew size, and machines suitable for swinging and processing whole Douglas-firs during cable thinning were evaluated. A rubber-tired cable skidder and a hydraulic knuckleboom loader were compared for efficiency in swinging logs. Costs were lower for the skidder than the loader.
KEYW Economics, machinery

81 AUTH Burton, J.D.
TITL Managing for high-value poles in the loblolly-shortleaf belt.
PUBL Southern Journal of Applied Forestry. 1(1): 11-15.
YEAR 1977
ABST A report on a long-term study of the effect of thinning methods and stand density on pole (assortment) yields and values, begun in 1950 in 20-year-old unthinned, second-growth Pinus taeda/P. echinata stands near Crossett, AR. Thinning treatments (from above or below) were applied to 0.1-acre plots over 25 years. Results showed that thinning from above produced more poles per acre (av. 85 to 113, including thinnings, compared with 71 to 99), while thinning from below produced larger poles and consequently higher pole values. Implications for forest management are discussed, especially of stands managed primarily for sawtimber.
KEYW Loblolly, methods, shortleaf, silviculture, South

82 AUTH Burton, J.D.
TITL Thinning and pruning influence glaze damage in a loblolly pine plantation.
PUBL Res. Note SO-264. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 4 p.
YEAR 1981
ABST An old-field plantation was thinned and pruned at age 11 and again at age 14 to four basal area levels and three crown percent levels. A survey was made to determine how damage by an ice storm at age 15 was influenced by treatment. Severe damage was heaviest in the densest stands and in stands with the shortest crowns, while the percent of stand destroyed was least under the heaviest thinning and lowest pruning. However, basal area and stems per acre in remaining growing stock were greatest under the lightest thinning and lowest pruning.
KEYW Damage, pruning

83 AUTH Burton, J.D.; Shoulders, E.
TITL Fast grown, dense loblolly pine sawlogs: a reality.
PUBL Journal of Forestry. 72(10): 637-641.
YEAR 1974
ABST In a 9-year-old loblolly pine plantation in southeast Arkansas, 25 well-spaced crop trees were marked in each of twelve 0.25-acre plots and the effects of four thinning treatments were compared: (a) intensive thinning at ages 9, 19, and 24 to leave, respectively, 100, 76, and 64 trees per acre; (b) intensive thinning at ages 9, 12, and 15 to remove noncrop trees whose crowns were within 5 feet of the crowns of crop trees and to leave 100 trees per acre, and at age 19 to leave 80 trees per acre; (c) intensive thinning at ages 12 and 24 to leave, respectively, 100 and 80 trees per acre; and (d) light thinning to a residual basal area of 85 square feet every 3 years (residual stocking 712 stems per acre at age 12 and 197 at age 24). In treatments (a), (b), and (c), crop trees were pruned to 50 percent of total height when thinning began and every 3 years thereafter until the clear bole averaged 333 feet at age 24: after age 19 the understory was controlled by mowing every 2 years. At age 27 , mean d.b.h. was 14 to 15 inches and standing volume 11,900 board feet per acre under intensive thinning but 10 inches and 5,300 board feet per acre under (d). Product value was greater under (d) up to age 18 but at age 27 the cumulative value of stands under intensive thinning exceeded that under (d) by 24 to 29 percent. Specific gravity of the wood at age 27 was unaffected by the treatments. The implications of these results for an early harvest of loblolly pine sawlogs is discussed.
KEYW Growth and yield, loblolly, methods, pruning, silviculture, South

84 AUTH Camisa, L.H.
TITL Sivicultural aspects of thinning loblolly pines in eastern Tennessee and northern Georgia.
PUBL APA Tech. Pap. 76-P-1. Washington, DC: American Pulpwood Association. 1 p.
YEAR 1975
ABST Loblolly pine plantations established since 1952 showed signs of overstocking by 1967, including mortality and a reduction in crown (length) to below a 35-percent ratio. Selective thinning from below in

order to maintain uniform stocking was begun in 1970 by mechanized crews. Results showed a reduction in total logging costs and an increase in average tree size and quality at the final harvest.
KEYW Loblolly, plantation, South

85 AUTH Cao, Q.V.; Burkhart, H.E.; Lemin, R.C., Jr.
TITL Diameter distributions and yield of thinned loblolly pine plantation.
PUBL FWS 1-81. Blacksburg, VA: Virginia Polytechnic Institute and State University, School of Forestry and Wildlife Resources. 62 p.
YEAR 1982
ABST A growth and yield model for thinned loblolly pine plantations was developed using data from 128 0.2-acre permanent plots in the Virginia Piedmont and coastal plain. The Weibull function, used to characterize stand diameter distributions, was searched to insure that the resulting total basal area and average d.b.h. estimates were identical to those predicted from stand variables using regression equations. The program within was written in standard Fortran to provide stand and stock tables for thinned old-field loblolly pine plantations. Trials with different thinning intensities indicated reasonable trends, as compared with published studies.
KEYW Growth and yield, loblolly, models, plantation, South

86 AUTH Carbonnier, C.
TITL Current Scandinavian thinking on thinning practice and yield.
PUBL New Zealand Journal of Forestry Science. 6(2): 357-361.
YEAR 1976
ABST Report on study of growth of spruce stands. The share of thinning in Scandinavian countries has diminished in favor of final cut volumes. Thinning schedules published by the Swedish National Board are based on basal area and top height. It foresees one to three low thinnings during a stand's rotation span.
KEYW Economics, growth and yield, systems, volumes

87 AUTH Carlestal, B.; Dehlen, R.
TITL Thinning methods for private forest owners.
PUBL Res. Note 105. Stockholm, Sweden: Royal College of Forestry, Department of Operational Efficiency. 2 p.
YEAR 1977
ABST Some present-day thinning methods that may be applicable for the private forest owner are presented and compared.
KEYW Damage, economics, forwarder, labor, machinery, safety, strip thinning

88 AUTH Cawrse, D.C.; Betters, D.R.; Kent, B.M.
TITL A variational solution technique for determining optimal thinning and rotational schedules.
PUBL Forest Science. 30(3): 793-802.
YEAR 1984
ABST An optimal control modeling approach is utilized to formulate a timber harvest scheduling problem for even-aged stands. The harvest problem involves simultaneously determining the optimal thinning and rotation schedule. The criterion of optimality utilized is the maximization of

present net value over an infinite series of rotations. Under appropriate assumptions, a variational solution technique is employed to develop an explicit optimal solution, to illustrate the formulation, and to show numerical results.

KEYW Models, silviculture

89 AUTH Chandler, K.C.

TITL Extraction thinning operations in young radiata pine at Kaingaroa Forest.

PUBL New Zealand Journal of Forestry Science. 6(2): 193-199.

YEAR 1976

ABST The past and present problems of extraction thinning on a large exotic forest of predominately easy topography are discussed in relation to previous silviculture and other competing logging operations. Despite a background of successful extraction thinning of other species and old crop Monterey pine, thinning of young Monterey pine has only recently become a silviculturally successful and economically viable operation. The relatively small tree size and high labor and capital content per unit volume produced are seen as the cause of poor past performances in this operation.

KEYW Economics, growth and yield, silviculture, steep slopes

90 AUTH Chibisov, G.A.; Moskaleva, S.A.

TITL The effect of thinning on the technical properties of spruce wood.

PUBL Lesnoe Khozyaistvo. 4: 12-14.

YEAR 1984

ABST Investigations were made in 50-year-old birch and spruce stands that had been thinned twice previously at ages 18 and 24. Data were tabulated on the physical and mechanical properties of the wood of large- and mean-diameter trees on each plot. Tracheid length of the spruce wood developing after thinning was also recorded. The results show that thinnings increase the late-wood percent, and that late-wood percent and wood density are not always closely related to ring width.

KEYW Juvenile wood

91 AUTH Choong, E.T.; Chang, B.Y.

TITL Effects of cultural treatments on density and growth in a loblolly pine plantation.

PUBL Wood Utilization Notes 25. Baton Rouge, LA: Louisiana State University. 4 p.

YEAR 1974

ABST Report of a study of the effects of initial spacing and of pruning and thinning treatments on the specific gravity and growth (radial increment) of loblolly pine assessed at age 22 in a Louisiana plantation. Spacing had a significant effect on radial growth rate, the greatest growth occurring at the widest spacing. Thinning at age 5 had no effect on growth; the effect of pruning, however, was significant 5 years after treatment. Thinning at age 11 significantly increased growth. Thinning had no significant effect on specific gravity. (Some difference in specific gravity found after thinning is attributed to the influence of spacing before thinning).

KEYW Growth and yield, loblolly, plantation, pruning, South, spacing

92 AUTH Clark, A., III
TITL Total tree and its utilization in the southern U.S.
PUBL Forest Products Journal. 28(10): 47-52.
YEAR 1978
ABST Equations for predicting weight of wood and bark in main stem and crown for red oak, yellow poplar, and the four major species of southern pine. Equations used to show various methods of harvest, what portion is removed, and what is left as residue. Full forest harvest can increase biomass yields 30 to 300 percent. Procedures for estimation are outlined. Results give percentage of different tree components and utilization for different species.
KEYW Biomass, chipping, equations, forecasts, growth and yield, hardwood, loblolly, longleaf, plantation, shortleaf, slash pine, South, systems, whole-tree

93 AUTH Clason, T.R.
TITL Hardwood eradication improves productivity of thinned loblolly pine stands.
PUBL Southern Journal of Applied Forestry. 8(4): 194-197.
YEAR 1984
ABST A single hardwood eradication treatment in a 7-year-old loblolly pine stand along with pine stocking control increased growth and yield over a 10-year period. Herbaceous vegetation control had no detectable effect at ages 12 and 17. Treated plots had smaller stems, which could be controlled more readily by fire, although the number of understory stems was similar for all treatments. Mean annual radial and merchantable volume growth on treated plots surpassed controls by 30 percent. Future stand values were enhanced by removing hardwood competition. Residual stand sawtimber volumes on the treated plots were twice those of the control.
KEYW Growth and yield, hardwood, loblolly, plantation, South

94 AUTH Clason, T.R.
TITL Removal of hardwood vegetation increases growth and yield of a young loblolly pine stand.
PUBL Southern Journal of Applied Forestry. 2(3): 96-97.
YEAR 1978
ABST A study in a natural 7-year-old stand of loblolly pine, with an overstory also dominated by sweetgum and water oak, and an understory including poison sumac, Smilax rotundifolia, winged elm, and willow oak. Four treatments, A, B, C, and D, were applied after precommercial thinning from 350 to 400 pines per acre: A = removal of broadleaf and herbaceous vegetation, B = removal of broadleaf vegetation only, C = removal of herbaceous vegetation only, and D = no treatment. Data are presented to show annual radial increment over 5 years, and stocking, d.b.h., height, and volume after 5 years of treatment. Treatment A significantly increased radial and volume increment (36 and 63 percent, respectively, more than controls), B accounted for increases of 23 and 45 percent, respectively, due to broadleaf control, and C concluded that removal of herbaceous vegetation has little effect. The removal of

hardwood in conjunction with precommercial thinning had an optimal increase in growth.
KEYW Growth and yield, loblolly

95 AUTH Clephane, T.P.
TITL The growing importance of southern timber.
PUBL In: Thinning southern pine plantations; southern forest economics workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 56-68.
YEAR 1980
ABST The changing timber demand is discussed together with its expected impact on timber prices and on the structure of the forest products industry. Some major conclusions are drawn for the future.
KEYW Economics, forecasts, growth and yield, South

96 AUTH Clutter, J.L.
TITL Compatible growth and yield models for loblolly pine.
PUBL Forest Science. 9(3): 354-371.
YEAR 1963
ABST Past studies in loblolly pine mensuration have resulted in the development of numerous analytic models for growth and yield. Most have treated growth and yield as essentially independent phenomena with no attempt to develop models that possess the logical compatibility that must exist between growth and yield observations. The present study develops models intended to express the relationships between growth and yield realistically. As an initial step, previously used basal area and cubic-foot yield models were examined and screened for use in the analysis. The yield models selected for use were differentiated with respect to age to produce models for cubic-foot and basal area growth. The resulting growth models, together with the selected model for cubic-foot yield were then fitted to data obtained in the 5- and 10-year remeasurements of 102 permanent sample plots located in three states. Equations were developed for cubic-foot yield, basal area growth, cubic-foot growth, basal area projection, and cubic-foot volume projection. Three of these equations can be used to predict total per acre production for various rotation ages and thinning regimes.
KEYW Growth and yield, loblolly, models, South

97 AUTH Cohan, D.; Haas, S.; Roussopoulos, P.J.
TITL Decision analysis of silvicultural prescriptions and fuel management practices on an intensively managed commercial forest.
PUBL Forest Science. 29: 858-870.
YEAR 1983
ABST The interactions between timber and fuel management activities suggest that decisions regarding these activities should be considered jointly. A decision analytic approach is used to identify important interactions and develop a general model integrating the natural processes, economic factors, and management activities central to these classes of decision. The model and analytical process are demonstrated in a case study application to a 2800-hectare plantation on the Stanislaus National Forest, where the most intensive of six treatment combinations examined--thinning and weeding the entire plantation combined with

complete fuel treatment--is preferred on the basis on net present value. Sensitivity analysis is used to evaluate the impact of uncertainties in data and model assumptions. The approach is potentially useful in a variety of forest situations.

KEYW Economics, models, silviculture

98 AUTH Cole, D.M.

TITL An indirect method for determining the order of expected thinning response among overstocked lodgepole pine stands.

PUBL Canadian Journal of Forest Research. 16(5): 875-879.

YEAR 1986

ABST Relationships for representing relative thinning response potential among overstocked lodgepole pine stands were investigated with data from 31 stands in 4 National Forests in Idaho.

KEYW Growth and yield, West

99 AUTH Cooley, J.H.

TITL Thinning and fertilizing red pine to increase growth and cone production.

PUBL Res. Pap. NC-42. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 8 p.

YEAR 1970

ABST Cone production and growth were increased more by heavy thinning than by fertilizing in 53- and 55-year-old natural red pine stands growing on medium sites, and in a 20-year-old plantation on a good site.

KEYW Fertilization, growth and yield, plantation, red pine

100 AUTH Cowdrick, R.M.; Gibson, H.G.; Cassens, D.L.

TITL Systems for biomass harvesting from natural hardwood stands.

PUBL ASAE Pap. 81-1597. St. Joseph, MI: American Society of Agricultural Engineers. 21 p.

YEAR 1981

ABST With the increasing demand for utilization of logging residues as biomass energy sources, hardwood logging residues have become a more viable source of wood fiber. Authors present a systems analysis of selected mechanical harvesting equipment for thinning natural hardwood stands, with the intent of utilizing the harvested material as biomass for use in fuelwood burners, multifuel systems, and for alcohol production, thus recovering the material at a profit.

KEYW Biomass, chipping, economics, feller-buncher, felling, hardwood, machinery, skidder, systems

101 AUTH Cremer, K.W.; Meredith, E.M.

TITL Growth of radiata pine after row thinning compared with selective thinning.

PUBL Australian Forestry. 39(3): 193-200.

YEAR 1976

ABST In a replicated trial near Canberra, first thinnings in a 16-year-old plantation of Monterey pine were made by felling every second row, felling every third row, felling every fifth row plus selected trees of poor vigor or form in intermediate rows, and felling selected trees. At

the time of thinning, mean dominant height was 73.1 feet and basal area 181.6 square feet per acre before thinning and 88.9, 121.5, 105.0 and 106.7 square feet per acre after the second row, third row, fifth row and selected tree thinnings respectively. During the 6 years after thinning, there was no significant difference in growth between fellings of second row and of third row or between fellings in intermediate rows and of selected trees. A highly significant difference between row and selection thinnings (volume growth was 17 percent less in row thinnings) was attributed to the greater percentage of small trees remaining after row thinnings: growth of the 102 largest trees per acre did not vary between treatments.

KEYW Growth and yield, machinery, plantation, row thinning, selective thinning

102 AUTH Crookston, W.L.
TITL Users guide to the event monitor: an addition to the prognosis model.
PUBL Gen. Tech. Rep. INT-196. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 36 p.
YEAR 1985
ABST The monitor offers an alternative method of scheduling management activities. During the simulation, specific conditions are monitored and appropriate management activities are scheduled. Examples show the use of the monitor to schedule thinning and regeneration and to create decision trees.
KEYW Economics, management

103 AUTH Crow, A.B.
TITL Intermediate treatment in pine plantations: current biological state of knowledge.
PUBL Timber Harvesting Rep. 3. Gulfport, MS: National Space Technology Laboratory. 17 p.
YEAR 1977
ABST Discussion at length on applied thinning to immature pine plantations for the purpose of stimulating growth and to increase total yield of useful material from the stand. Considers three important aspects of thinning applications: (1) method, (2) intensity, and (3) frequency or cycle. The effects of thinning on tree growth, yield, quality, site, soil, insect damage, and disease are also discussed. Thinning and other intermediate treatments can have profound biological effects on plantation development and derived benefits.
KEYW Growth and yield, juvenile wood, methods, plantation

104 AUTH Crow, A.B.
TITL Why thin pine stands?
PUBL Forest Farmer. 23(2): 8, 15-16.
YEAR 1963
ABST An experiment in a slash pine plantation in southeastern Louisiana illustrates accomplishments and methods of thinning.
KEYW Plantation, slash pine

105 AUTH Crowe, M.
TITL Can-car hydrostatic clipper.
PUBL Canberra, Australia: Machine Evaluation Harvesting Research Group, Division of Forest Research, CSIRO. p. 4, 3 Pl., 3. 1 p.
YEAR 1975
ABST The large (Canadian) feller-buncher is mounted on a rubber-tired articulated chassis and incorporates a felling head on a knuckle-boom mounted on a turntable over the front axle. Results of a 3-day field trial of the machine in a 20-year-old Monterey pine plantation in Stromlo Forest near Canberra indicate some of the merits and limitations of the clipper and provide evidence of its productivity in a thinning operation. The manufacturer's specifications are given.
KEYW Feller-buncher, machinery, plantation

106 AUTH Cubbage, F.W.
TITL Are small-scale harvest systems cost competitive?
PUBL ASAE Pap. 81-1588. St. Joseph, MI: American Society of Agricultural Engineers. 16 p.
YEAR 1981
ABST Average southern pine pulpwood harvest costs are determined for alternative scale harvest systems using computer simulation. Secondary costs and benefits are discussed. General conclusions are made regarding the economic feasibility of small-scale systems.
KEYW Economics, models, pulpwood, South, systems

107 AUTH Cubbage, F.W.; Granskog, J.E.
TITL Harvesting systems and costs for southern pine in the 1980's.
PUBL Forest Products Journal. 32(4): 37-43.
YEAR 1982
ABST Timber harvesting systems and their costs are a major concern for the forest products industries. Harvest costs per cord are estimated, using computer simulation, for current southern pine harvesting systems. The estimations represent a range of mechanization levels. The sensitivity of systems to factors affecting harvest costs--machine costs, fuel prices, wage rates, tract size, and planted stands--is examined to determine trends in harvest systems and costs. Highly mechanized full-tree systems are the most cost-efficient and should increase in number in the 1980's. Tree-length systems and labor-intensive systems fall at the next average cost level, partially mechanized systems having the highest average costs. Adoption of highly mechanized harvest operations will be inhibited by increasing real costs for machines and interest, high average costs on small tracts, and depressed markets. Yet this type of system will retain a substantial cost advantage for average harvest. Decreasing labor availability and continued need for plantation thinning also favor use of mechanized full-tree systems. If sufficient progress is made toward the adoption of the most efficient systems, logging costs could rise less than the general inflation rate. Real cost increases may occur if depressed economic conditions and high machine costs prevent loggers from adopting highly mechanized systems because such systems must maintain stable, high volumes of output.
KEYW Economics, labor, longwood, machinery, models, plantation, shortwood, South, systems

108 AUTH Czerepinski, F.P.
TITL Evaluation of harvesting systems used in pine plantations in the Southeast.
PUBL APA Tech. Pap. 78-P-7. Washington, DC: American Pulpwood Association. 1 p.
YEAR 1978
ABST Equipment, procedures, and output are presented for five harvesting systems. Advantages and disadvantages of the systems are described.
KEYW Clearcut, growth and yield, plantation, systems

109 AUTH Czerepinski, F.P.
TITL Trends of the eighties.
PUBL APA Tech. Pap. 81-P-31. Washington, DC: American Pulpwood Association. 8 p.
YEAR 1981
ABST The past and present state of logging in the South is described, and its needs in the decade of the 80's are predicted. The problems that must be overcome are also described along with the types of equipment that must either be developed or come into greater use to deal with these problems.
KEYW Damage, economics, forecasts, machinery, methods, South, systems

110 AUTH Dahlin, B.O.
TITL Winding strip-roads in first thinnings.
PUBL Rep. 136. Stockholm, Sweden: Royal College of Forestry, Department of Operational Efficiency. 2 p.
YEAR 1980
ABST For lack of strip-roads, some trees that should be left for the final felling (target trees) have to be cut in thinnings. By winding strip-roads between these target trees, it is possible to decrease the number that have to be cut. Simulations were done in order to study the benefits and drawbacks of winding strip-roads.
KEYW Damage, machinery, models, strip thinning

111 AUTH Daniels, R.F.
TITL Spatial patterns and distance distributions in young seeded loblolly pine stands.
PUBL Forest Science. 24(2): 260-266.
YEAR 1978
ABST Spatial patterns were examined for forty 5- to 12-year old loblolly pine stands of seed origin using point-to-plant distance methods. The stands had been regenerated by seed tree, natural (old-field), aerial, or broadcast seeding. Pielou's nonrandomness index indicated that clumping was prevalent in all regeneration methods. Index values were not correlated with age, stand density, or average tree size, and differences could not be attributed to regeneration method. Observed distance frequencies were further described by continuous distributions derived from poison and negative binomial assumptions of plant distribution used in quadrat (plot) sampling. The Pearson type XI distribution, derived from the negative binomial assumption, fits the observed distances well and should prove useful in spatial modeling.
KEYW Equations, loblolly, models, South, spacing

112 AUTH Daniels, R.F.; Burkhart, H.E.
TITL Simulation of individual tree growth and stand development in managed loblolly pine plantations.
PUBL FWS-5-75. Blacksburg, VA: Virginia Polytechnic Institute and State University, School of Forestry and Wildlife Resources. 69 p.
YEAR 1975
ABST A Fortran-based simulator, PTAEDA, was developed to model growth in managed loblolly pine plantations, using individual trees as the basic growth units. In PTAEDA, trees are assigned coordinate locations in a stand and grown annually as a function of their size, the site quality, and the competition from neighbors. Growth increments are adjusted by stochastic elements representing genetic and microsite variability. Mortality is generated stochastically through Bernoulli trials. Subroutines were developed to simulate the effects of site preparation, thinning, and fertilization on tree and stand development. Comparisons with published yields showed close agreement for thinned and unthinned old-field plantations. Results indicated that, compared to stand-level models used in the past, the simulator is more flexible in terms of growth and yield estimation and evaluation of alternatives under a wide range of management regimes.
KEYW Fertilization, growth and yield, loblolly, models, plantation, South

113 AUTH Daniels, R.F.; Burkhart, H.E.; Strub, M.R.
TITL Yield estimates for loblolly pine plantations.
PUBL Journal of Forestry. 77(9): 581-583, 586.
YEAR 1979
ABST Three stand models, representing a range of alternatives for loblolly pine yield estimation, were evaluated and compared with independent data on the basis of merchantable cubic-foot yield estimates. The comparisons included a multiple regression model, a diameter distribution model, and an individual tree simulation model. Using observed number of trees and average height of dominants and codominants on the test plots, analysis of deviations of estimated from observed yields revealed that (1) all three models provided accurate estimates; (2) all models were free from prediction bias resulting from stand conditions; and (3) the regression and diameter distribution models were more precise than the individual-tree simulation model. Selection of a model depends on the amount of stand detail desired and the management practices to be evaluated.
KEYW Growth and yield, loblolly, models, plantation, South

114 AUTH Danielsson, B.
TITL Harvesting and transportation of small, whole trees in Sweden.
PUBL ASAE Pap. 83-1599. St. Joseph, MI: American Society of Agricultural Engineers. 17 p.
YEAR 1983
ABST Tree-section harvesting is an increasingly important method of thinning. Information is provided about technique, productivity, and costs compared with other methods of harvesting, transportation, and processing.
KEYW Economics, methods, processing, shortwood, whole-tree

115 AUTH Dargavel, J.B.
TITL Evaluating the role of thinning in development forestry.
PUBL New Zealand Journal of Forestry Science. 6(2): 242-252.
YEAR 1976
ABST The problems encountered in evaluating the role of thinning are displayed by considering a simple general development model for the creation of new forest industries and their associated plantations. Thinning is seen as having an important role in achieving objectives. The current position in developing models to aid decisions is explored by reviewing models used at the stand, plantation, and national levels in Australia and New Zealand.
KEYW Economics, models, plantation

116 AUTH Dell, T.R.; Driver, C.H.
TITL The relationship of d.b.h. to fusiform stem cankering in old-field slash pine plantations.
PUBL Journal of Forestry. 61(11): 872.
YEAR 1963
ABST The occurrence of stem cankers was investigated as related to tree d.b.h. in planted slash pine. The diameter distribution data from fifty-four 1/4-acre plots showed that tree size was not related to the occurrence of stem cankers. Thus a sanitation thinning of stem-cankered trees should not affect the normal distribution of diameter classes of similar stands.
KEYW Diseases, plantation, slash pine

117 AUTH Denninger, W.
TITL For thinning operations in the central German highlands. Foma 1984--demonstration of efficient mobile harvesting systems.
PUBL Holz-zentralblatt. 110: 1412-1413.
YEAR 1984
ABST The study evaluated the following methods: Swedish bench method (chain saw conversion and extraction using a crane-equipped forwarder); Brunett mini 678P processor along skidding lane; Wolfegg method for one-man cable line thinning and conversion using a Steyr trimmer/cross cutter; Makeri 33T harvester; whole tree chipping along skidding lane; and transport of large timber using a Steyr KSK 16 cable crane.
KEYW Cable system, forwarder, harvester, processor, systems

118 AUTH Dennington, R.W.; Westbrook, R.F.; Dillard, P.W.
TITL Modern technology can improve strategy for thinning timber.
PUBL Forest Farmer. September: 12-13.
YEAR 1986
ABST The effects of chip-and-saw markets on thinning strategies are discussed.
KEYW Row thinning, strip thinning

119 AUTH Dickerson, B.P.
TITL Changes in the forest floor under upland oak stands and managed loblolly pine plantations.
PUBL Journal of Forestry. 70(9): 560-562.
YEAR 1972
ABST Plots in a 33-year-old loblolly plantation (mean basal area 130 square feet per acre) in northern Mississippi were either: (a) clearfelled, (b) thinned to 75 square feet per acre, or (c) left untreated as controls. Three years later, the forest floor under (a) averaged 3 tons per acre less, under (b) 1 1/2 tons per acre less than under (c). Annual litter fall showed an 18-percent decline in (b). A related study in an 80-year-old mixed hardwood stand consisting mainly of oak showed that killing the hardwood overstory with injections of 2-4-D caused a rapid breakdown of the forest floor. However, lesser vegetation rapidly invaded the treated plots, and material clipped from this vegetation was nearly equal in weight to the average annual litter on untreated control plots.
KEYW Chemicals, damage, loblolly, plantation, site, South

120 AUTH Diggle, P.J.; Knutell, H.
TITL "Kniggle," a new method for estimating strip-road width.
PUBL Rep. 125. Stockholm, Sweden: Royal College of Forestry, Department of Operational Efficiency. 2 p.
YEAR 1979
ABST As a method for reliable and objective estimation of strip-road width, the "Kniggle" method is described along with other estimation methods and performances.
KEYW Machinery, models, strip thinning

121 AUTH Dostal, D.
TITL A new logging system for smallwood on steep slopes.
PUBL Holz-zentralblatt. 111(113): 1610-1612.
YEAR 1985
ABST Work studies were performed during thinning operations in two Norway spruce stands that were ages 35 and 37, respectively. The equipment used was a skidder equipped with a boom and winch. Hours were recorded for man and machine to produce cost and production rates throughout the different phases of harvesting.
KEYW Machinery, selective thinning, skidder

122 AUTH Drakenberg, K.; Kardel, L.
TITL Winch thinning and the forest-recreation environment.
PUBL Res. Note 80. Stockholm, Sweden: Royal College of Forestry, Department of Operational Efficiency. 2 p.
YEAR 1974
ABST The damage to soil and vegetation that usually appears after conventional (strip-road) thinnings is deleterious. To find out if such damage could be reduced, winch thinning was tested in two forest stands.
KEYW Damage, economics, site, strip thinning, systems

123 AUTH Dunfield, J.D.
TITL Mechanized precommercial thinning of dense trees.

PUBL Info. Rep. FMR-X-64. Ottawa, Ontario, Canada: Forest Management Institute. 47 p.
YEAR 1974
ABST An account is given of the historical background of mechanical, precommercial thinning and of the work undertaken by the Forest Management Institute in developing a prototype mechanical thinning machine. The report includes descriptions of a number of commercial brush cutters and their field tests in corridor-thinning dense, young softwood stands in eastern Canada.
KEYW Damage, economics, machinery, precommercial thinning

124 AUTH Dunham, P.H.
TITL Will a thinning cut pay?
PUBL Forest Farmer. 45(10): 10-11.
YEAR 1986
ABST Information is provided to help decide if thinning is a variable management tool, together with discussion of advantages and disadvantages of early thinning.
KEYW Forecasts, management, silviculture

125 AUTH Dutrow, G.F.; Daiser, H.F.
TITL Economic opportunities for investments in forest management in the Southern United States.
PUBL Southern Journal of Applied Forestry. 8(2): 76-79.
YEAR 1984
ABST There are investment opportunities on 88 million acres of Southern forest lands that offer competitive financial rates of return. Some of these investments will yield positive rates of return above inflation even with declining stumpage prices. Opportunities included stocking control, stand conversion, and harvesting and regeneration of mature stands.
KEYW Economics, silviculture, South

126 AUTH Dykstra, D.P.; Aulerich, E.D.
TITL Prebunching to reduce helicopter logging cost.
PUBL Journal of Forestry. 76(6): 362-364.
YEAR 1978
ABST One effort is described to quantify rates and costs of helicopter production for thinning young-growth Douglas-fir in Oregon. The logs in a small sale were skidded to landings by horse, and then flown about 2,400 feet. Total logging costs were $265 per thousand board feet instead of $440 per thousand board feet.
KEYW Bunching, damage, economics, helicopter, steep slopes, systems

127 AUTH Enghardt, H.G.
TITL Early thinning--by individual trees or by rows?
PUBL In: Symposium on planted southern pines; 1948 October 22-23; Cordele, GA. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southeastern Area, State and Private Forestry: 84-91.
YEAR 1968

ABST Reports of the advantages and disadvantages of selective and row thinning.
KEYW Diseases, growth and yield, plantation, row thinning, selective thinning, South, spacing

128 AUTH Enghardt, H.G.
TITL Row or selection thinning.
PUBL Forest and People.(19(2): 34-45.
YEAR 1969
ABST Discussion is presented of advantages and disadvantages of both row and selective thinning, including advice on which to use for given stand conditions and final product.
KEYW Plantation, row thinning, selective thinning

129 AUTH Enghardt, H.G.; Mann, W.F., Jr.
TITL Ten-year growth of planted slash pine after early thinnings.
PUBL Res. Pap. SO-82. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 11 p.
YEAR 1972
ABST Volume growth of slash pine between ages 17 and 27 was directly related to residual basal area per acre after thinning. Diameter growth was inversely related to stand density, and very heavy cutting was required to attain a rate of 3 inches in 10 years.
KEYW Growth and yield, plantation, slash pine, South, volumes

130 AUTH Erdmann, A.
TITL Further development of thinning technologies for middle-aged Scots pine stands--problems and tendencies.
PUBL Beitrage Fur Die Forstwirtschaft. 19(1): 18-24.
YEAR 1985
ABST A discussion of the possibilities of mechanization during thinning of pine stands in East Germany and of a theoretical analysis of the percentage of stems accessible to a boom used in conjunction with a Makeri 33T feller-buncher. Thirty- to 80-year-old stands were classified into four groups based on passibility by machine.
KEYW Feller-buncher, machinery

131 AUTH Eriksson, L.
TITL Single-tree competition models predicting stand development after cleaning.
PUBL Stockholm, Sweden: Swedish University of Agricultural Sciences, College of Forestry, Department of Operational Efficiency. 34 p.
YEAR 1977
ABST Study was aimed to gain information on stand development after treatment for single trees. Increments of about 300 pine and spruce trees at heights between 4 and 33 feet were estimated by several different competition models.
KEYW Equations, forecasts, growth and yield, models, precommercial thinning, selective thinning, strip thinning

132 AUTH Eriksson, L.
TITL Strip roads and damages caused by machines when thinning stands.
PUBL Rep. 137. Stockholm, Sweden: Swedish University of Agricultural Sciences, Royal College of Forestry, Department of Operational Efficiency. 2 p.
YEAR 1981
ABST Discussion is presented of damage to stands caused by strip-roads.
KEYW Roads

133 AUTH Evans, S.
TITL Modifying small crawler tractors for thinning.
PUBL Tech. Rel. 6(1). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1984
ABST Discussion of the modifications made to two Caterpillar D3B's and two Komatsu D31A's for thinning radiata pine stands.
KEYW Machinery, precommercial thinning, radiata pine, row thinning, selective thinning, steep slopes, strip thinning, systems

134 AUTH Farrar, R.M., Jr.
TITL Density control--natural stands.
PUBL In: Proceedings of the symposium on the loblolly pine ecosystem (west region); 1984 March 20-22; Jackson, MS. [Place of publication unknown]: [Publisher unknown]. [Number of pages unknown].
YEAR 1984
ABST Background and definitions for density control in selection stands of loblolly-shortleaf pine are discussed. Density control methods are presented in the context of two methods of regulating the cut in uneven-aged stands: a volume-guiding diameter limit and a basal-area--maximum-d.b.h.-Q method. Applications are illustrated graphically. Submerchantable stand density and unwanted vegetation control considerations are also discussed.
KEYW Growth and yield, loblolly, selective thinning, silviculture

135 AUTH Farrar, R.M., Jr.
TITL Southern pine site index computing program.
PUBL Res. Note SO-197. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 8 p.
YEAR 1975
ABST A Fortran program is described whereby site index (or height) tables for southern pines may be computed for any index age and array of integer age and height (or site index). The program uses interpolation equations developed for the site index curves in United States Department of Agriculture Misc. Pub. 50.
KEYW Models, site, South

136 AUTH Farrar, R.M., Jr.
TITL Southern pine site index equations.
PUBL Journal of Forestry. 71(11): 696-697.
YEAR 1973

ABST Equations are presented for the site index curves in United States Department of Agriculture miscellaneous publication 50. They make possible computer calculation of site index for the four major southern pines.
KEYW Equations, loblolly, longleaf, shortleaf, site, slash pine, South

137 AUTH Farrar, R.M., Jr.
TITL Status of growth and yield information in the South.
PUBL Southern Journal of Applied Forestry. 3(4): 132-137.
YEAR 1979
ABST An overview of the status of stand growth and yield information for the South. Included are: a chronological review of the development of prediction systems for Southern timber types; state-of-the-art examples from the literature; and an assessment of future needs in growth and yield information.
KEYW Forecasts, growth and yield, South

138 AUTH Feduccia, D.P.
TITL Growth and yield of planted slash pine on cutover sites in the West Gulf.
PUBL In: Proceedings of symposium on management of young pines; 1974 December 3-5; Charleston, SC. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 97-107.
YEAR 1974
ABST Summary and commentary on recent publications dealing with initial planting spacing, timing of first thinnings, and choice of thinning intensity. Results show: (a) volume growth was directly related to number of stems planted and residual basal area per acre after thinning, (b) diameter growth was inversely related to planting rate and stand density, (c) early and heavy thinning reduced volume growth, and (d) cordwood growth excelled on unthinned plots in early years.
KEYW Growth and yield, methods, slash pine, South, spacing

139 AUTH Feduccia, D.P.
TITL Ten-year growth following thinning of slash pine planted on medium to poor cutover sites.
PUBL Res. Pap. SO-137. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 6 p.
YEAR 1977
ABST For slash pine planted on medium to poor cutover sites and selectively thinned, periodic annual cubic-foot volume and basal area growth were directly related to residual basal area per acre and site index, and inversely related to age during two 5-year growth periods. Higher densities caused a decrease in diameter for dominant trees and for all trees.
KEYW Equations, growth and yield, plantation, selective thinning, site, slash pine, South

140 AUTH Feduccia, D.P.
TITL Thinning pine plantations.
PUBL Forest Farmer. 42(10): 10-11.

YEAR 1983
ABST Brief explanations and recommendations are given on southern plantations for thinning methods, timing, and intensity.
KEYW Methods, plantation

141 AUTH Feduccia, D.P.
TITL Thinning planted slash pine on cutover flatwood sites in the West Gulf.
PUBL Res. Pap. SO-158. New Orleans, LA: U.S. Department of Agriculture, Southern Forest Experiment Station. 8 p.
YEAR 1979
ABST Eight thinning regimes started at age 17 and an unthinned control were compared for slash pine planted on a productive cutover site in southwest Louisiana. Over 20 years, cubic-foot volume growth increased directly with residual basal area. Growth of the check plots fell below that of the thinning treatments because of high mortality between ages 27 and 37. Diameter increment was related inversely to stand density, and growth of merchantable trees did not exceed 0.28 inch yearly in any treatment. Sawtimber production generally followed the trend of cubic-foot volume, only four thinning treatments produced more standing volume by age 37 than did the control.
KEYW Growth and yield, plantation, slash pine, South

142 AUTH Feduccia, D.P.; Dell, T.R.; Mann, W.F., Jr.; Campbell, T.E.; Polmer, B.H.
TITL Yields of unthinned loblolly pine plantations on cutover sites in the West Gulf region.
PUBL Res. Pap. SO-148. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 88 p.
YEAR 1979
ABST Equations and tables are developed to help predict yields on loblolly pine plantations specifically in the West Gulf region.
KEYW Equations, forecasts, growth and yield, loblolly, plantation, South

143 AUTH Feduccia, D.P.; Mann, W.F., Jr.
TITL Bark thickness of 17-year-old loblolly pine planted at different spacings.
PUBL Res. Note SO-210. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 2 p.
YEAR 1976
ABST Loblolly pine were planted at five initial spacings on plots with site indices of 77 to 111 feet in southwest Louisiana. Data collected during the first thinning showed that d.b.h. was the only variable affecting bark thickness at the bottom and at the midpoint of the merchantable stem. Bark thickness at the 4-inch top was not correlated with d.b.h.
KEYW Equations, loblolly, South, spacing

144 AUTH Feduccia, D.P.; Mann, W.F., Jr.
TITL Black turpentine beetle infestations after thinning in a loblolly pine plantation.
PUBL Res. Note SO-206. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 3 p.

YEAR 1975
ABST Black turpentine beetle infestations can be reduced substantially by minimizing injuries to residual trees during logging and avoiding harvesting on waterlogged soils to prevent excessive root damage. After thinning, losses can be minimized by spraying visibly injured trees immediately with lindane, checking susceptible stands frequently for infestations, and applying lindane as soon as beetles are discovered.
KEYW Chemicals, damage, loblolly, plantation, South

145 AUTH Feduccia, D.P.; Mann, W.F., Jr.
TITL Growth following initial thinning of loblolly pine planted on a cutover site at five spacings.
PUBL Res. Pap. SO-120. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 8 p.
YEAR 1976
ABST Following first thinning, cubic-foot volume growth between ages 17 and 22 for loblolly pine planted at various initial spacings was directly related to residual basal area per acre and site index. Diameter growth was inversely related to number of merchantable trees per acre after cutting at age 17. Regression equations are given to predict these parameters.
KEYW Equations, growth and yield, loblolly, plantation, spacing

146 AUTH Fender, D.E.
TITL Thinning alternatives in pine plantations.
PUBL In: Management of pine plantations: Proceedings of 7th Auburn Forestry Forum; 1968 [Month unknown]; Auburn, AL: Auburn University, Cooperative Extension Service: 29-39.
YEAR 1968
ABST On examining reasons for thinning, and some aspects of thinning, the author concludes that thinning normally stocked slash and loblolly pine plantations can increase net income by providing an early return on investment and shortening the rotation.
KEYW Diseases, economics, loblolly, methods, plantation, row thinning, selective thinning, slash pine, South

147 AUTH Fenton, R.H.
TITL The economics of thinning.
PUBL New Zealand Journal of Forestry Science. 6(2): 273-282.
YEAR 1976
ABST The economic evaluation of thinning should include the interaction of tree-stand, utilization, linked economic, and local management factors. Needed tree-stand data include malformation percentage, mortality rates, stand volume, piece-size projections, changes in timber quality, and hydrological and ground cover effects. Utilization data include the differential costs and returns of each piece-size class. Linked economic data include differential haul rates, returns to scale of utilization plants, and economic multiplier effects through time. Local influences include biological, climatic, and topographic considerations. Opportunity costs can include reduction in final crop increment rate, postponement of cash flows from greater volumes of clearfellings, and postponement of linked utilization benefits. As

thinning is a more complex operation than clearfelling, the postponement of the greater yields forgone should be justified when production thinning is prescribed.
KEYW Damage, economics, growth and yield, safety, volumes

148 AUTH Fenton, R.H.; Bond, A.R.
TITL The silvics and silviculture of Virginia pine in southern Maryland.
PUBL Res. Pap. NE-27. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 37 p.
YEAR 1964
ABST Virginia pine is primarily a pulpwood species because of small size, coarse and persistent branches, and susceptibility to heart rot at a fairly young age. At present, thinning and pruning are not recommended, although thinning has unproven long-term value.
KEYW Growth and yield, pulpwood, silviculture

149 AUTH Field, R.C.; Clutter, J.L.; Jones, E.P., Jr.
TITL Predicting thinning volumes for pine plantations.
PUBL Southern Journal of Applied Forestry. 1(2): 59-61.
YEAR 1978
ABST Equations are presented for estimating the volume removed in thinning from below when the desired reduction in basal area or number of stems is known. The estimators are based on data from slash pine plantations but the methods may be useful for other species.
KEYW Equations, forecasts, models, plantation, slash pine, South, volumes

150 AUTH Fitzgerald, C.H.; Fortson, J.C.
TITL Release and precommercial thinning of natural loblolly pine seedlings with Bromacil.
PUBL Athens, GA: University of Georgia, School of Forest Resources. 2 p.
YEAR 1979
ABST In trials for loblolly pine release on an upland site in Piedmont Province, Wilkes County, GA, three replications of two Bromacil treatments were given as spot applications to 0.1-acre plots, and the remaining stand area was injected. The Bromacil treatments compared favorably with standard 2.4-D-Amine injection treatments and reduced pine seedlings to densities more favorable to growth while eliminating hardwoods and tall, nonmarketable pine whips.
KEYW Chemicals, loblolly

151 AUTH Flick, W.A.; Bowers, J.R.; Trenchi, P., III
TITL Loblolly pine plantations in southern highlands: some financial guides.
PUBL Southern Journal of Applied Forestry. 4(2): 107-113.
YEAR 1980
ABST The profitability of growing loblolly pine plantations in the southern highlands of Alabama, Georgia, and Tennessee is analyzed and graphical guides are presented. All calculations show before-tax profitability. Present net worth ranges from $200 to over $1,000, depending on initial conditions. Internal rates of return range from 2 to 11 percent. The effect of professional forestry decisions on profitability is discussed.
KEYW Economics, loblolly, plantation, South

152 AUTH Folkema, M.P.
TITL Evaluation of Kockums 880 Tree King feller-buncher.
PUBL Tech. Rep. TR.13. Quebec, Quebec, Canada: Forest Engineering Research Institute of Canada. 16 p.
YEAR 1977
ABST A wheeled feller-buncher with chain saw head was capable of high productivity under a variety of conditions. It operated on 30-percent slopes, but had flotation problems in wetlands.
KEYW Economics, feller-buncher, machinery

153 AUTH Foran, W.M.; Wells, C.G.
TITL Steep country thinning systems.
PUBL LIRA Rep. 6(4). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1981
ABST An assessment is given of systems used to thin steep country in New Zealand.
KEYW Cable system, economics, helicopter, longwood, shortwood, skidder, steep slopes

154 AUTH Fountain, M.S.; Burnett, F. E.
TITL Ice damage to plantation grown loblolly pine in south Arkansas.
PUBL Arkansas Farm Research. 28(3): 3.
YEAR 1979
ABST Damage caused to a 32-year old plantation by an ice storm in 1978-79 is reported. The plantation had been thinned in the year preceding the storm to a basal area of 85 square feet per acre. Following the storm, the basal area was reduced to 46 square feet per acre, with 40 percent of damaged trees in the higher size classes. It is recommended that in vulnerable stands thinnings should start at an early age and be light and frequent, that trees infected by rust should be removed, and that trees with symmetrical crowns be retained.
KEYW Damage, diseases, loblolly, plantation, silviculture, South

155 AUTH Fowler, G.D.
TITL A method to log small woodlots.
PUBL The Northern Logger and Timber Processor. 28(3): 16-17.
YEAR 1970
ABST A small woodlot logging system utilizing a Kubota Model 245 tractor and a Farmi JL20 winch is described.
KEYW Damage, machinery, skidder

156 AUTH Fox, W.; Edwards, J.L.
TITL Evaluation of brush-cutters: Hydro Ax and Kershaw.
PUBL [Unnumbered]. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southern Region. 14 p.
YEAR 1973
ABST Number of stems per acre, average d.b.h., and production rates are given for sites in the south and portions of the Coastal Plain, Piedmont, and

Ozark highlands; also a discussion of benefits to wildlife and a manufacturer's report on changes in equipment design of the machines used.

KEYW Machinery, precommercial thinning, wildlife

157 AUTH Francois, F.; Andre, P.; Devillez, P.

TITL Effect of thinning intensity on extinction of solar radiation in young white spruce stands.

PUBL Annales Des Sciences Forestières. 42(3): 323-337.

YEAR 1985

ABST A study was made of the quantitative and qualitative changes in the solar radiation penetrating below the canopy. When stand density was reduced, the visible light increased by 185 percent, while the total solar radiation increased 96 percent.

KEYW Silviculture

158 AUTH Freese, F.

TITL A collection of log rules.

PUBL Gen. Tech. Rep. FPL 1. Madison, WI: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 65 p.

YEAR 1973

ABST A brief description is given of a number of log rules that have been used in the United States and Canada, also some general volume formulas, lumber measures, and foreign log rules.

KEYW Damage

159 AUTH Fridley, G.E.; Fridley, J.L.; Jorgensen, J.E.; Mann, C.N.

TITL Analysis and design of long booms for feller-bunchers in thinning operations.

PUBL Transactions of the ASAE. St. Joseph, MI: American Society of Agricultural Engineers. 29(3): 696-701.

YEAR 1986

ABST A long boom attached to a feller-buncher is beneficial for thinning trees on steep slopes where prime-mover mobility is restricted. Design parameters that affect the ability of an operator to address and lift individual trees were identified by analyzing boom/vehicle tipover stability, boom structural integrity, and the time required to address an individual tree.

KEYW Feller-buncher, steep slopes

160 AUTH Fridley, J.L.; Garbini, J.L.; Jorgensen, J.E.; Peters, P.A.

TITL An interactive simulation for studying the design of feller-bunchers for forest thinning.

PUBL Transactions of the ASAE. St. Joseph, MI: American Society of Agricultural Engineers. 28(3): 680-686.

YEAR 1985

ABST An interactive numerical simulation method is described employing a stand map, thinning prescription, and a model harvest vehicle. Geometric parameters and an operating strategy are used to generate a feasible cutting path for a feller-buncher. Results indicate that the

technique is suitable for evaluating design and operational parameters and their effects on thinning system performance.
KEYW Feller-buncher, selective thinning

161 AUTH Fridley, J.L.; Jorgensen, J.E.
TITL Geometric modeling to predict thinning system performance.
PUBL ASAE Pap. 81-1594. St. Joseph, MI: American Society of Agricultural Engineers. 14 p.
YEAR 1981
ABST Thinning system performance is analyzed in terms of stand and machine system parameters. These are identified and relationships developed to describe their effects. The relationships developed can be used to evaluate new and different concepts in thinning. A feller-buncher for use on steep slopes is used to illustrate the models.
KEYW Equations, feller-buncher, forecasts, machinery, models, steep slopes, systems

162 AUTH Fridley, J.L.; Jorgensen, J.E.
TITL Identification and analysis of operational characteristics of feller-bunchers thinning on steep slopes.
PUBL Tech. Rep. FE-UW-8102. Seattle, WA: University of Washington, College of Engineering. 36 p.
YEAR 1981
ABST Discussion of operational characteristics of feller-bunchers applying thinning treatments on steep slopes.
KEYW Feller-buncher, steep slopes

163 AUTH Fridley, R.B.; Holtman, J.B.
TITL A machine for selective stocking control in plantations.
PUBL ASAE Pap. 84-1606. St. Joseph, MI: American Society of Agricultural Engineers. 14 p.
YEAR 1984
ABST A machine was developed to selectively thin plantations with row integrity. One model was demonstrated to be effective for stocking control without recovery of cut stems. A second model demonstrated the feasibility of gathering the stems.
KEYW Equipment, plantation, selective thinning

164 AUTH Fries, J.
TITL Value of residual stand: principal views.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 21-27.
YEAR 1969
ABST Reasons for choosing a thinning program are discussed.
KEYW Equations, forecasts, growth and yield, methods

165 AUTH Froelich, R.C.; Hodges, C.S., Jr.; Sackett, S.S.
TITL Prescribed burning reduces severity of annosus root rot in the South.
PUBL Forest Science. 24(1): 93-100.
YEAR 1978

ABST Prescribed burnings of 14 loblolly and slash pine plantations in the coastal plain of the Southern United States often reduced losses to Heterobasidion annosus root rot. Plots on which losses were reduced were burned twice before initial stand thinning, and one to three times after thinning. The beneficial effect of fire was greatest where stump infection was assured by inoculation of all fresh stumps with spores of the fungus. Trichoderma spp., fungal competitors of Heterobasidion annosus, increased in soil after burning on burned plots. A heavy legume cover, Sericea lespedeza, does not provide better disease control than burning alone.
KEYW Chemicals, diseases, loblolly, plantation, slash pine, South

166 AUTH Gaskin, J.E.
TITL Organized felling for thinning radiata pine.
PUBL LIRA Rep. 8(12). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1983
ABST Discussion of how organized felling techniques for production thinning of radiata pine have been applied and the advantages and disadvantages of production thinning.
KEYW Felling, radiata pine, row thinning, selective thinning, site, skidder

167 AUTH Gilmore, A.R.; Boggess, W.R.
TITL Growth and yield from row thinning in a shortleaf pine plantation in southern Illinois.
PUBL Forestry Note 126. Urbana, IL: University of Illinois, Agricultural Experiment Station. 3 p.
YEAR 1969
ABST Three 1/5-acre row-thinned plots were established in 1951. The results of thinning applications are reported and the total growth and yield since thinning compared with those of adjacent shortleaf pine plots that were thinned by a crown method to 80 square feet of basal area or left unthinned as controls. Volumes were determined from local volume tables constructed from the thinned trees.
KEYW Growth and yield, plantation, row thinning, shortleaf

168 AUTH Gleason, A.P.; Stulen, J.A.
TITL Prebunching in thinnings.
PUBL LIRA Rep. 9(3). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1984
ABST A report is given of thinnings using the Bell logger with discussions of prebunching productivity and its effect on the productivity and cost of the entire operation.
KEYW Bunching, economics, felling, machinery, selective thinning, skidder

169 AUTH Gobel, J.R.; Warner, J.R.; Van Lear, D.H.
TITL Periodic thinning in loblolly pine stands: growth, yield, and economic analyses.
PUBL Forest Res. Series 28. Clemson, SC: Clemson University, Department of Forestry. 11 p.

YEAR 1974
ABST Loblolly pine plantations established in the late 1930's in the South Carolina Piedmont have been studied for the past 20 years to evaluate effects of periodic thinnings on growth and yield. With pulpwood rotations, economic analyses indicate no advantage from thinnings, although thinnings resulted in marked increases in diameter growth. Thinning should be economically advantageous when growing loblolly pine on longer rotations by reducing the time required for residual trees to reach sawtimber size with high value growth.
KEYW Economics, growth and yield, loblolly, plantation

170 AUTH Gordon, R.D.
TITL A new cable logging concept for thinning.
PUBL Tech. Rel. 1(4). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1979
ABST Discussion of a new cable logging concept and machine (Steyr Timber-veyer) introduced for mechanized thinning in steep country, including the general specifications and operating principle of this comparatively different cable logging concept.
KEYW Cable system, machinery, selective thinning, steep slopes

171 AUTH Graham, J.N.; Bell, J.F.; Herman, F.R.
TITL Response of sitka spruce and western hemlock to commercial thinning.
PUBL Res. Pap. PNW-334. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 17 p.
YEAR 1985
ABST Relatively light commercial thinning in a 100-year-old mixed stand on the Cascade Head Experimental Forest near Otis, OR, was prescribed to preserve wind firmness of the stands, reduce or arrest all mortality and concentrate potential growth on selected trees. Thinning regimes applied between 1947 and 1951 removed 15 to 25 percent of basal area. Measurements were made between 1947 and 1964. Unthinned natural stands averaged about 30 percent more gross growth and 10 percent more net growth than thinned stands. It is concluded that stands with a small (less than 20 percent) component of western hemlock may not respond as well to commercial thinning as stands with a larger (greater than 35 percent) component. Gross growth seemed to be greater in stands of higher density, both thinned and unthinned. In the least dense stand, however, with about 340 square feet per acre of basal area, gross growth was enhanced by thinning.
KEYW Growth and yield

172 AUTH Grammel, R.
TITL Summary of present and planned research and development projects on harvest in thinning stands in the Federal Republic of Germany.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 242-244.
YEAR 1969
ABST A list is given of research projects in Germany.
KEYW Economics, labor, pulpwood, systems

173 AUTH Grano, C.X.
TITL Growth of planted loblolly pine after row and selective thinning.
PUBL Res. Note SO-123. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 3 p.
YEAR 1971
ABST A combination of row and selective thinning was practical and cubic yields were similar to those from selective thinning in a loblolly pine plantation in southern Arkansas. Removing alternate rows in two cuts resulted in smaller tree diameters than selective thinning.
KEYW Growth and yield, loblolly, plantation, row thinning, selective thinning, South

174 AUTH Grano, C.X.
TITL Precommercial thinning of loblolly pine.
PUBL Journal of Forestry. 67(11): 825-827.
YEAR 1969
ABST Machine and hand thinnings beginning at age 7 increased height growth and yield in an over-dense loblolly pine stand. It appears that in order to be most profitable, precommercial thinning should be done by machine at age 2 or 3 to at least an 8- by 8-foot spacing.
KEYW Equations, growth and yield, loblolly, precommercial thinning, South, spacing, systems

175 AUTH Grano, C.X.
TITL Small hardwoods reduce growth of pine overstory.
PUBL Res. Pap. SO-55. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 9 p.
YEAR 1970
ABST Dense understory hardwoods materially decreased the growth of a 53-year-old and a 47-year-old stand of loblolly and shortleaf pines. Hardwood eradication with chemicals increased average annual yield from the 53-year-old stand by 14.3 cubic feet, or 123 board feet per acre over a 14-year period and from the 47-year-old stand by 32.6 cubic feet, or 342 board feet per acre, over an 11-year period.
KEYW Chemicals, growth and yield, hardwood, loblolly, shortleaf, South

176 AUTH Granskog, J.E.
TITL Harvesting costs for mechanized thinning systems in slash pine plantations.
PUBL Res. Pap. SO-141. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 7 p.
YEAR 1978
ABST Harvesting costs of four tree harvester systems are estimated for row thinning slash pine plantations. Systems incorporating a full-tree type harvester had lower harvesting costs per cord than shortwood and tree-length harvester systems in 15-year-old plantations.
KEYW Economics, machinery, plantation, row thinning, slash pine, systems, whole-tree

177 AUTH Granskog, J.E.
TITL Labor for thinning--trends and prospects.
PUBL In: Thinning southern pine plantations: Proceedings of southern forest economics workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 105-116.
YEAR 1980
ABST Discussion is presented of labor for thinning, with a review of improved efficiency from investment in labor and equipment, increased industry support for worker training, management assistance, economic research, and programs that reduce workers' compensation cost.
KEYW Forecasts, labor, South, training

178 AUTH Granskog, J.E.
TITL Tree harvesting productivity studied in slash pine plantations.
PUBL Forest Industries. 102(10): 49-50.
YEAR 1975
ABST Three tree harvesters were studied: TH-100 Thinner-harvester, Caterpillar 950 tree harvester and Soderhamm Go Go harvester. Time study data were gathered on each machine to develop regression equations for predicting processing times under various conditions. Equations were developed to calculate hourly production rates.
KEYW Equations, harvester, machinery, plantation, row thinning, slash pine, South

179 AUTH Granskog, J.E.; Anderson, W.C.
TITL Dense undergrowth reduces feller-buncher productivity in shortleaf pine plantations.
PUBL Res. Note SO-274. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 4 p.
YEAR 1981
ABST Production rates of a feller-buncher are shown for row thinning pine plantations with light and dense undergrowth conditions. Dense undergrowth reduced machine output by about 20 percent.
KEYW Row-thinning, timber harvesting, tree harvester

180 AUTH Granskog, J.E.; Anderson, W.C.
TITL Harvester productivity for row thinning loblolly pine plantations.
PUBL Res. Pap. SO-163. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 5 p.
YEAR 1980
ABST Two tree harvesters currently being used to thin southern pine plantations were evaluated to determine effects of stand characteristics on machine productivity.
KEYW Economics, equations, harvester, loblolly, machinery, plantation, row thinning, South

181 AUTH Grayburn, A.W.
TITL Kinleith thinning operations of N.Z. Forest Products Unlimited.
PUBL New Zealand Journal of Forestry Science. 6(2): 214-220.
YEAR 1976
ABST Assuming the decision had been made to carry out production thinning at various ages, the scope and development of the thinning operations in

ABST the Kinleith Forests are traced since they first started on a production scale in 1958. The evolution of extraction techniques is discussed as well as the significance of the thinning volume in the overall wood supply to the Kinleith integrated mills. Crew production is discussed and the way in which the contract payment rates were determined is described. A table of the thinning prescription is included. The various limitations on such an operation are dealt with as they occur in the forest, during loading and transporting, as well as in the mill yard and plant. So long as labor can be obtained for this work and costs can be contained by overall efficiency, the higher cost thinning wood will be acceptable in the total wood supply mix for the mill.

KEYW Economics, labor, loading, longwood, machinery, shortwood, skidder, systems, volumes

182 AUTH Greene, W.D.; Lanford, B.L.

TITL Geometric simulation of feller-bunchers in southern pine plantation thinning.

PUBL ASAE Pap. 84-1612. St. Joseph, MI: American Society of Agricultural Engineers. 17 p.

YEAR 1984

ABST Interactive simulation is used to simulate the activities of a drive-to-tree feller-buncher in plantation thinnings. An inexpensive microcomputer with simple graphics capability provides adequate detail to model the workings of a feller-buncher in dense stands.

KEYW Feller-buncher, machinery, models, plantation, South

183 AUTH Greene, W.D.; Lanford, B.L.

TITL A grapple processor for plantation thinning.

PUBL Forest Products Journal. 35(3): 60-64.

YEAR 1985

ABST Small boom-mounted grapple processors are popular in Scandinavia where they eliminate manual delimbing, bucking, and piling of trees. One such machine, the Valmet 940 grapple processor, was tested in a first thinning of loblolly pine in Alabama. The processor followed a small feller-buncher which built large bunches (16 stems) at about 27-foot intervals along an access corridor. The processor delimbed and bucked the wood into 7.5-foot bolts, forming a neat pile at the side of the access corridor for subsequent forwarding. Production averaged 2.5 stems per minute. Regression equations were developed to predict processing time per tree, moving time per tree, and total time per tree. Processing time per tree was greatly dependent on average tree size. Moving time per tree was closely related to the distance traveled from the previous bunch and the number of trees in the current bunch. Total time per tree was almost identical to processing time which formed the major component of total time. Slash piles remaining after forwarding were much smaller with this system than with manual methods because tops were deposited in the access corridors where subsequent machine traffic reduced the slash. Such a processor appears well suited to southern pine thinnings where it can replace dangerous and physically demanding manual operations.

KEYW Machinery, plantation, thinning

184 AUTH Greene, W.D.; Lanford, B.L.
TITL A grapple processor for plantation thinning.
PUBL Journal 9-84651. Auburn University, AL: Alabama Agricultural Experiment Station. 20 p.
YEAR 1985
ABST A Volvo BM Valmet 940 GP grapple processor was examined in a first thinning of loblolly pine in southern Alabama. The processing head delimbs, bucks, and piles single or multiple stems and can be mounted on most conventional front-end loaders. Production averaged 2.5 stems per minute when working from large piles (16 stems) built by a feller-buncher. Equations for processing time and moving time are presented. Use of such a processor appears to offer more safety and silvicultural benefits than manual delimbing, bucking, and piling.
KEYW Machinery, plantation, processor

185 AUTH Greene, W.D.; Lanford, B.L.
TITL Potential for second thinnings in southern pine plantations.
PUBL In: Shoulders, Eugene, ed. Proceedings of the third biennial southern silvicultural research conference; 1984 November 7-8; Atlanta, GA. Gen. Tech. Rep. SO-54. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 212-215.
YEAR 1984
ABST In a recent survey, most forest products firms in the South indicated plans to thin their pine plantations two or more times in a rotation. Additional research is necessary to improve methods for second and later thinnings.
KEYW Economics, plantation, selective thinning

186 AUTH Greene, W.D.; Lanford, B.L.; Hool, J.N.
TITL Potential product volumes from second thinnings of southern pine plantations.
PUBL Forest Products Journal. 37(3): 8-12.
YEAR 1987
ABST Compatible taper and volume equations were used to estimate the potential of market for products from trees harvested during the second thinning of a southern pine plantation. Estimates were produced for products obtained from both tree-length and product-length logging.
KEYW Management, pulpwood, selective thinning, shortwood

187 AUTH Greene, W.D.; Lanford, B.L.; Myaytka, E.F.
TITL Stand and operating effects on feller-buncher productivity in second thinnings of southern pine.
PUBL Forest Products Journal. 37(3): 27-34.
YEAR 1987
ABST The effects of stand and operating factors on the productivity of a small feller-buncher in second-thinning applications were studied in an intensive experiment using interactive simulation. Three first-thinning treatments, three levels of stand density prior to second thinning, three levels of stand density after second thinning, two spacings between corridors, and three target bunch sizes were considered in a fully replicated experiment.
KEYW Feller-buncher, forwarder, loblolly, plantation

188 AUTH Greene, W.D.; Lanford, B.L.; Stokes, B.J.
TITL Productivity of the Valmet 940 GP grapple processor in southern pine plantation thinning.
PUBL In: Corcoran, Thomas J.; Gill, Douglas R., eds. Proceedings of the COFE/IUFRO conference; 1984 August 11-18; Orono, ME: University of Maine: 105-108.
YEAR 1984
ABST A Valmet 940 grapple processor was added to a mechanized thinning crew, replacing three sawhands and improving the quality of wood produced. Addition of the processor slightly improved the productivity of the forwarders and provided a better method for disposal of the remaining slash after delimbing and bucking. Such processors appear promising to replace dangerous and less productive manual delimbing and bucking operations in the South.
KEYW Plantation, processor, South

189 AUTH Greene, W.D.; Lanford, B.L.; Tufts, R.A.
TITL Evaluation of harvesting systems for the second thinning of southern pine plantations.
PUBL Forest Products Journal. 37(6): 9-14.
YEAR 1987
ABST Six thinning systems were examined to determine their ability to perform second thinnings. The systems included tree-length and product-length material using skidders or forwarder. System performance was measured while conducting simulated second thinning treatments.
KEYW Equipment, feller-buncher, forwarder, limbing, loading, multiproduct, plantation, skidder, systems

190 AUTH Griffin, G.
TITL Mechanized thinning crew requires precision landing.
PUBL Forest Industries. 114(3): 22-23.
YEAR 1987
ABST Small thinning operation is discussed together with equipment, production rates, startup, and operating procedures.
KEYW Equipment, feller-buncher, limbing, skidder

191 AUTH Griffin, G.
TITL Right machinery key to thinning crew's success.
PUBL Forest Industries. 113(8): 18-19.
YEAR 1986
ABST Discussion is presented of starting and operating a thinning crew, and equipment and methods used by the logger.
KEYW Equipment, methods, row thinning

192 AUTH Griffin, G.
TITL Swedish processors aid thinning crew's operation.
PUBL Forest Industries. 111(11): 23-25.
YEAR 1984

ABST A modern thinning operation is discussed utilizing: (1) two Volvo GP 940's mounted in JD 444 units, (2) two Morbell feller bunchers, (3) three Gafner 5050 iron mule prehaulers, and (4) a JD 544 front-end loader.
KEYW Equipment, safety, shortwood

193 AUTH Griffin, G.
TITL Young thinning crew sets high standards.
PUBL Forest Industries. 113(8): 16-17.
YEAR 1986
ABST Discussion of starting and operating a small thinning crew, and equipment and methods used by the logger.
KEYW Equipment, feller-buncher, silviculture, skidder

194 AUTH Grinchenko, V.V.
TITL Damage to trees during thinnings.
PUBL Lesnoe Khozyaistvo. [Vol. unknown](12): 23-25.
YEAR 1984
ABST Tables show the incidence and severity of damage to residual trees during thinnings in 17 stands of Scots pine ranging from 19 to 71 years.
KEYW Damage, selective thinning

195 AUTH Grosenbaugh, L.R.
TITL New measurement concepts: height accumulation, giant tree, taper, and shape.
PUBL Occasional Pap. 134. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 31 p.
YEAR 1954
ABST An entirely new concept of tree measurement was announced by the author in 1948. Because the original theory and applications have subsequently been broadened considerably, the entire development is published here in readily usable form, along with other material helpful in tree measurement. A giant-tree table also is made available for the first time, and tree taper and shape are discussed.
KEYW Volumes

196 AUTH Grosenbaugh, L.R.
TITL Tree form: definition, interpolation, extrapolation.
PUBL Forestry Chronicle. 42(4): 13.
YEAR 1966
ABST Definition of tree form requires numerous measurements of height and stem radius or diameter distributed over the entire tree stem. Further definition may involve a graphic plot of stem profile, an analytic expression of radius as a polynomial or rational polynomial function of distance from apex, or the direct numeric evaluation of the major integrals of tree form (length, surface, volume). Linear, quadratic, or harmonic interpolation over short intervals can assume a monatomic one-parameter function without introducing serious error. Extrapolation should employ a two-parameter function passing through the origin and based on three measured pairs of coordinates. Appropriate surface and

volume integrals are given for the convex right hyperbola and the concave parabola.
KEYW Equations, volumes

197 AUTH Gruschow, G.F.; Evans, T.C.
TITL The relation of cubic-foot volume growth to stand density in young slash pine stands.
PUBL Forest Science. 5(1): 49-55.
YEAR 1959
ABST Data from seven studies in northeastern Florida and southeastern Georgia are analyzed relating growth to stand density in young slash pine stands.
KEYW Equations, growth and yield, slash pine, South

198 AUTH Guttenburg, S.
TITL Growth and mortality in an old-field southern pine stand.
PUBL Journal of Forestry. 52(3): 166-168.
YEAR 1954
ABST The effects of several cutting treatments are compared in a dense old-field stand of loblolly and shortleaf pine, demonstrating that such stands are capable of good response, even when they are well past the age at which the first thinning for sawlog production should be made.
KEYW Growth and yield, loblolly, shortleaf, South

199 AUTH Haberle, S.
TITL Logging techniques in thinnings today and tomorrow in western middle-Europe with special reference to Germany.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 83-85.
YEAR 1969
ABST In this part of Europe, stands have been densely planted. Thinning intervals are 3 to 5 years beginning at age 10. A summary of different layouts is included. Time and costs are reported for manual felling with tractor skidding.
KEYW Forecasts, labor, machinery, methods

200 AUTH Hafley, W.L.; Buford, M.A.
TITL A bivariate model for growth and yield prediction.
PUBL Forest Science. 31(1): 237-247.
YEAR 1985
ABST An application of Johnson's SBB distribution is made to growth and yield prediction. Mathematical techniques are detailed for describing stand structure and projecting yield for thinned and unthinned stands of loblolly pine in plantations.
KEYW Equations, growth and yield

201 AUTH Hagerdon, C.W.; Wong, C.P.
TITL Thinning in exchange for firewood.
PUBL Journal of Forestry. 84(7): 44-46.
YEAR 1986

ABST A successful trial was held in which the public was allowed to fell marked trees in dense ponderosa pine stands that required thinning. In 1984, thinning by the public cost $18 per acre, whereas hire of a thinning crew cost $54 per acre.
KEYW Economics

202 AUTH Haggstrom, B.
TITL Thinning practice in Sweden.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 34-38.
YEAR 1969
ABST Discussion of the nature of thinning stands, types of thinning, and their economics.
KEYW Economics, methods, silviculture

203 AUTH Haines, S.G.
TITL Site preparation and cultural treatments affect growth of planted Pinus taeda L.
PUBL Tech. Rep. 60. Raleigh, NC: North Carolina State University, School of Forest Resources. 1 p.
YEAR 1978
ABST A comparison of 10 combinations of (a) discing, (b) fertilization, (c) herbicide application, (d) soil fumigation, (e) subsoiling, (f) mowing, and (g) irrigation, either before planting on an old-field in North Carolina (Piedmont zone) or during the first growing season (1975). Data are tabulated for the growth response after one and two growing seasons. Treatment had no significant effect on survival. The other data, including biomass components and their nutrient contents, showed no significant difference between treatments until the second year, when positive response was generally greater for treatments involving (c) and least for (a), (f), and controls. After multivariate analysis of variance for each biomass variable, root collar diameter was selected as giving the most accurate measure of effect. Inclusion of any other combination of variables did not improve the analysis, possibly because the planting stock was superior and of uniform size. An economic analysis was made for three forest management options: all treatments except (d) and (g) appeared feasible for industrial forests, but (e) was feasible only in combination with options involving thinning.
KEYW Biomass, chemicals, economics, fertilization, growth and yield, loblolly, methods, plantation, silviculture

204 AUTH Hakansson, S.G.
TITL Space requirements for forwarders in thinning.
PUBL Res. Note 114. Stockholm, Sweden: Royal College of Forestry, Department of Operational Efficiency. 2 p.
YEAR 1977
ABST Calculations are made that describe the influence of vehicle dimensions, obstacle height, and maximum steering on space requirement. Simple geometric calculation models are used.
KEYW Damage, forwarder, machinery, spacing, strip thinning

205 AUTH Hakkila, P.
TITL Whole-tree chipping in thinning operations: an industrial point of view.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 180-184.
YEAR 1969
ABST Report on the use of green chips in Finland.
KEYW Chipping, machinery, whole-tree

206 AUTH Hakkila, P.; Kalaja, H.; Slalkari, M.; Valonen, P.
TITL Whole-tree harvesting in the early thinning of pine.
PUBL Folia Forestalia. 333: 1-58.
YEAR 1977
ABST The techniques of felling, bunching, chipping, and hauling of whole Scots pine trees in early thinning are described. Attention is paid to the composition of the biomass in a young Scots pine stand, the measurement of whole-tree raw material, and truck transport. The productivity of work and costs are compared with those for alternative harvesting schedules.
KEYW Biomass, economics, juvenile wood, machinery, whole-tree

207 AUTH Hakkila, P.; Leikola, M.; Slalkari, M.
TITL Production, harvesting, and utilization of small sized trees.
PUBL [Place of publication unknown]: The Finnish National Fund for Research and Development: 46B. 163 p.
YEAR 1979
ABST Discussion of short-rotation of hardwood in Finland, and Rep. on intensive production methods and whole-tree harvesting.
KEYW Bunching, chipping, damage, feller-buncher, felling, machinery, plantation, whole-tree

208 AUTH Hall, M.J.
TITL A plantation simulation model for radiata pine.
PUBL Appita. 27(4): 25-261.
YEAR [Year unknown]
ABST Measurements from all the company's spacing and thinning trials have been pooled, growth models calculated, and a program called predict developed that simulates stand development, estimates assortments, growing costs, net present values, and mean harvesting costs for various thinning schedules and rotations. Each thinning can be identified as to age and intensity of thinning on the basis of thinning either to a residual basal area or to a volume to be cut per acre. Options on thinning type enable simulations of mechanical thinning (all diameter classes), thinnings from below (small diameter classes), thinnings from above (large diameter classes), or a combination of mechanical with either below or above as would occur in a thinning involving removal of rows for access and selection thinning. A series of runs on this model within the bounds of the data used indicate that Pinus radiata is a very flexible species. The type of thinning does affect final crop tree size but does not greatly affect growing costs or volume production: as thinning intensity is raised, volume production is lost, but this does not affect growing costs greatly as the economic benefit from larger earlier returns compensates for lower productivity where thinnings are

heavy. Net present values fall as stocking per acre is increased, although volume production rises. As rotation age increases to 20 years, volume production rises steadily while harvesting costs fall rapidly. Extrapolating the data beyond 20 years indicates a maximum net present value at 30 to 35 years.

KEYW Economics, growth and yield, models, plantation, spacing, volumes

209 AUTH Halls, L.K.
TITL Managing deer habitat in loblolly-shortleaf pine forest.
PUBL Journal of Forestry. 71(12): 752-757.
YEAR 1973
ABST Recommendations are given for the management of shortleaf and loblolly pine forests in the southern United States to improve the habitat for the whitetail deer. Available food can be increased by wide spacing, frequent thinning, maintaining hardwoods on drainage ways, prescribed burning, regulating the size, shape, and distribution of clearfellings, providing openings in the forest, and encouraging preferred food plants.
KEYW Loblolly, shortleaf, South, spacing, wildlife

210 AUTH Hamilton, D.A., Jr.
TITL A logistic model of mortality in thinned and unthinned mixed conifer stands of northern Idaho.
PUBL Forest Science. 32(4): 989-1000.
YEAR 1986
ABST A mortality model is described based on a series of thinned and unthinned sample plots, some of which have been measured for 70 years. Independent variables are d.b.h., stand basal area, annual diameter growth, relative d.b.h., and species.
KEYW Damage, diseases

211 AUTH Hamilton, G.J.
TITL Line thinning.
PUBL England: Linney's of Mansfield. 27 p.
YEAR [Year unknown]
ABST The effects are given of line thinning on growth and yield, crop stability, damage risk, and harvesting of sitka spruce, including discussion of soil moisture, wind damage, extraction damage, soil damage, and other effects on soil, and snow and ice damage. Different types of thinning systems are also reported.
KEYW Cable system, damage, economics, equations, forwarder, growth and yield, machinery, methods, skidder, systems

212 AUTH Hannelius, S.
TITL Summary: initial tree spacing in Norway spruce timber growing--an appraisal of yield and profitability.
PUBL Folia Forestalia. 359: 1-51.
YEAR 1978
ABST The investigation examined initial tree spacing in the cultivation of Norway spruce as it affected yield, timber production, and profitability. Lower densities improved the diameter increment at burst height and dominant height. Higher initial densities increased the

growth of basal area and volume. Tapering of trees was least in the most densely planted plots. Profitability calculations showed 1,500 to 1,800 plants per hectare to be the most recommended densities in spruce plantings on good sites in southern Finland.

KEYW Growth and yield, spacing

213 AUTH Hannula, O.
TITL The effect of average stand diameter on tree length logging costs.
PUBL Pulp and Paper Magazine of Canada. 72(2): 96-100.
YEAR 1971
ABST On tree-length clearcut pulpwood operations in western Alberta, the average butt diameter has a definite effect on production and costs. In spruce stands, production increases an average of 2.9 cords per day for every 1-inch increase in average butt diameter. Production in pine increases an average of 3.7 cords per day for every 1-inch increase in average butt diameter up to 11 inches, where production levels off. Consequently, logging costs decrease per cord as production increases.
KEYW Clearcut, economics, longwood

214 AUTH Hapla, F.
TITL X-ray densitometric studies on wood properties of Douglas-fir from experimental plots given various thinning treatments.
PUBL Holz Als Roh-und Werkstoff. 43(1): 9-15.
YEAR 1985
ABST Studies were made on stem core samples taken in 1983 from 40 Douglas-fir trees in a 53-year-old Douglas-fir/Norway spruce stand including plots that had been lightly and moderately thinned. Growth, moisture content, and wood density were analyzed to determine their effect on wood properties.
KEYW Growth and yield, selective thinning

215 AUTH Hardie, I.W.
TITL Optimal management plans for loblolly pine plantations in the mid-Atlantic region.
PUBL Pap. 906. College Park, MD: Agricultural Experiment Station. 107 p.
YEAR 1977
ABST The formulation of an economic management model is described for typical loblolly pine plantations in the mid-Atlantic region, and the results of over 100 runs of the model are presented. One purpose of the modeling effort is to determine the maximum potential profitability of loblolly pine plantations in the study region, another is to discover which management practices will maximize net returns from the plantation investment. Management practices tested by the model include length of rotation, timing of thinnings and thinning intensities. Practices such as fertilization and pruning are not considered. The report also gives information about methodology as well as findings.
KEYW Loblolly, models

216 AUTH Harmon, G.R.
TITL Mechanization for the small timberland owner.
PUBL Forest Farmer. 30(1): 8-10.

YEAR 1970
ABST Discussion of the potential of multipurpose attachments to the farm tractors used by small producers.
KEYW Machinery

217 AUTH Harms, W.R.
TITL Applying silvics to stand management.
PUBL In: Proceedings of the symposium on the loblolly pine ecosystem (west region): 1984 March 20-22; Jackson, MS. [Place of publication unknown]: [Publisher unknown]. [Number of pages unknown].
YEAR 1984
ABST Three guiding concepts are proposed: (1) any silvicultural decision affects all future silvicultural decisions. Failure to appreciate that management actions influence basic physical and biological processes of the site and thereby tree and stand growth in complex and long lasting ways can result in costly errors that may be difficult if impossible to correct; (2) bringing a growth-limiting factor closer to its optimum level will increase production. Applying a knowledge of silvics to the concept of limiting factors can enable the silviculturist to diagnose and often correct site and stand conditions that prevent attainment of potential growth; (3) silvicultural requirements change with stand development. Five distinct stages of development can be recognized in even-aged stands: regeneration/establishment, precompetition, competition/ premortality, competition/self thinning/, and post competition. At each stage there are needs and opportunities for silvicultural intervention to maintain or improve growth. Taken together, these concepts provide a basis for developing biologically and economically sound silvicultural prescriptions.
KEYW Economics, growth and yield, silviculture, site

218 AUTH Harms, W.R.
TITL Spacing--environmental relationships in a slash pine plantation.
PUBL Pap. SE-150. Ashville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 16 p.
YEAR 1962
ABST The influence of tree spacing on the relationship between diameter growth and prevailing environmental conditions was investigated in a 6-year-old slash pine plantation. The study was designed to determine whether differences in diameter growth were related to soil moisture, rainfall, evaporation, wind, and soil and air temperature.
KEYW Growth and yield, plantation, site, slash pine, spacing

219 AUTH Harms, W.R.; Collins, A.B., III
TITL Spacing and twelve-year growth of slash pine.
PUBL Journal of Forestry. 63(12): 909-912.
YEAR 1965
ABST Comparison made at age 12 of eight spacings of old-field planted slash pine showed that average tree diameter was positively correlated with wider spacing. The relationship was linear; beginning in the 8th and intensifying through the 12th year, the relationship was curvilinear. Tree height was positively correlated with wider spacing. There was a positive curvilinear relationship between crown ratio and wider

spacing. Wider configuration, whether square or rectangular spacings were used, did not affect diameter growth. Merchantable cubic volume yield did not show a clear relationship to spacing.

KEYW Growth and yield, slash pine, South, spacing

220 AUTH Harms, W.R.; Langdon, O.G.

TITL Development of loblolly pine in dense stands.

PUBL Forest Science. 22(3): 331-337.

YEAR 1976

ABST Annual measurements (stem number, total height, d.b.h.) were made on twenty 0.04-hectare plots in a 3- to 14-year-old naturally regenerated stand of loblolly pine in the lower coastal plain of South Carolina. The plots were thinned at age 3 to density classes ranging from 2,500 to 40,000 uniformly spaced stems per hectare. In the 14th year, a sample of each density treatment was harvested. Net aboveground dry matter (biomass) yield per hectare was estimated by logarithmic regression analysis. The influence of density on mortality, on growth in d.b.h. and height, and on volume and biomass yield is shown in figures and tables. The total biomass per hectare of the tree crown components (branches and foliage) was less affected by stand density than was biomass of the stemwood and stem bark.

KEYW Growth and yield, loblolly

221 AUTH Harms, W.R.; Lloyd, F.T.

TITL Stand structure and yield relationships in a 20-year-old loblolly pine spacing study.

PUBL Southern Journal of Applied Forestry. 5(3): 162-166.

YEAR 1981

ABST Further results from a study established in 1956-57 in South Carolina to assess four spacings (6 by 6 feet, 10 by 10 feet, and 12 by 12 feet). Height and d.b.h. were measured for all trees surviving at age 20. Maximum merchantable volume (3,887 feet per acre) and a near maximum basal area (187 square feet per acre) was produced by the 8- by 8-foot spacing. All but the 6- by 6-foot spacing had sawtimber at age 20 whereas only the 12- by 12-foot spacing had sawtimber at age 15. Sawtimber volume and survival both increased with spacing. The 8- by 8 and 10- by 10-foot spacings both promoted pulpwood and sawtimber production, utilization of all surviving trees, and an early return from thinning.

KEYW Growth and yield, loblolly, South, spacing, volumes

222 AUTH Harrington, C.A.; Reukema, D.L.

TITL Initial shock and long-term stand developments following thinning in a Douglas-fir plantation.

PUBL Forest Science. 29(1): 33-46.

YEAR 1983

ABST Responses have been monitored for 25 years following the application of six precommercial thinning treatments to a 27-year-old Douglas-fir plantation (2.4-meter spacing, height at age 100=24 meters). Spacing after thinning ranged from 3.4 meters to 8.1 meters. Immediately following thinning, trees exhibited thinning shock; that is, substantial reduction of growth in height. The severity and duration of the shock

were partially related to the severity of thinning. From 15 to 25 years following thinning, however, growth in height was positively related to growing space with the best height growth at the wider spacings. Growth in diameter increased following thinning, with the range in diameter growth rates between spacings increasing over time. Basal area and volume growth per hectare were reduced by treatment, but the differences between spacings are decreasing.

KEYW Growth and yield, plantation, precommercial thinning, spacing, West

223 AUTH Harrison, W.C.; Burk, T.E.; Beck, D.E.
TITL Individual tree basal area increment and total height equations for Appalachian mixed hardwoods after thinning.
PUBL Southern Journal of Applied Forestry. 10(2): 99-104.
YEAR 1986
ABST Data were collected on 66 permanent plots at the time of thinning and 5 years after thinning. Regression equations were developed to predict growth response to thinning.
KEYW Equations, growth and yield, hardwood

224 AUTH Harstela, P.; Jarvinen, J.; Tervo, L.; Aholainen, R.
TITL Summary: the study of some shortwood methods of cutting in thinnings (cutting without bunching and scrape method).
PUBL Folia Forestalia. 310: 1-29.
YEAR 1977
ABST A study was made to compare the cutting without bunching (scattered) and the so-called scrape (Lleka) method in thinnings with the conventional method of cutting to the side of the strip-road. In addition to the output and costs of the work, the critical strain on the workers and the residual growth were also studied.
KEYW Economics, equations, systems

225 AUTH Hartler, N.
TITL Raw material and technical development in the fiber industry.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 185-191.
YEAR 1969
ABST Discussion of wood properties and utilization of trees in Sweden.
KEYW Biomass, chipping, multiproduct, pulpwood

226 AUTH Hassler, C.C.; Sinclair, S.A.; Ferguson, D.J.
TITL Trends in pulpwood logging costs during the 1970's.
PUBL Forest Products Journal. 31(9): 53-58.
YEAR 1981
ABST Laspeyres fixed weight, fixed base indexes were developed for four hypothetical pulpwood logging firms for the years 1970 through 1979. The cost indexes were compared with pulpwood price indexes and the Bureau of Labor Statistics' Producer Price Index to determine if costs had increased at a different rate than pulpwood prices or the producer price index. The average cost increase from 1970 through 1979 for the four hypothetical firms was 153.1 percent. The increase in the producer price index was significantly smaller than the increase in costs for any

ABST of the four firms. Increases in logging costs (indexes) were significantly greater than increases in pulpwood prices (indexes) for four selected Wisconsin pulpwood species. The most rapidly increasing elements of logging costs were worker's compensation and fuel.
KEYW Economics, pulpwood

227 AUTH Haver, G.F.
TITL Intermediate cutting in pine plantations: future directions for research and practices.
PUBL Timber Harvesting Rep. 3. Gulfport, MS: National Space Technology Laboratory. [Number of pages unknown].
YEAR 1977
ABST Because planting at heavier stocking levels results in more complete utilization of the site, thinning is used as a means of increasing the wood supply in the South. To answer questions regarding the exact levels of stocking for various sites and methods of removing stems during thinning, the approach used here is to view thinning as a system combining three models (biological, harvesting, and handling), and build an optimization model. The biological model supplies the values, the harvesting and handling models the costs that are used as input to the optimization model. This system approach can help evaluate many questions concerning thinning. Presentation of the model highlights some key research needs.
KEYW Economics, forecasts, models, plantation, silviculture, South

228 AUTH Hayden, W.Y.
TITL Rocky Creek Logging continues to hone thinning operation...Valmet 940 processors improve safety/productivity; limit damage.
PUBL American Logger and Lumberman. 9(5): 10-12.
YEAR 1984
ABST Discussion of recent improvements in the thinning operation at Rocky Creek, and of the new Valmet 940 processors and the improvements in productivity and safety resulting from their use.
KEYW Equipment, processor, row thinning

229 AUTH Hearst, A.L., Jr.
TITL Utilizing residues--more material from more trees.
PUBL In: Proceedings of Forest Research Society 28th annual meeting; 1974 June 23-27; Chicago, IL. Madison, WI: Forest Products Research Society. [Number of pages unknown].
YEAR 1974
ABST Discussion of new machines and work done in Montana.
KEYW Harvester, machinery, precommercial thinning, systems, whole-tree

230 AUTH Hedbring, O.; Nilsson, P.O.; Akesson, H.
TITL Analysis of some logging systems for thinning.
PUBL Rep. 4. Stockholm, Sweden: Skogsarbeten Logging Research Foundation. 50 p.
YEAR 1968

ABST A systematic examination is made of some possible machines and logging systems for thinning. Theoretical machine models are examined, and production, cost, and labor requirements estimated.
KEYW Chipping, economics, equations, feller-buncher, harvester, labor, machinery, models, processor, strip thinning, systems

231 AUTH Heden, S.
TITL Preliminary report on an investigation concerning the influence on yield of tractor logging in thinnings.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 131-135.
YEAR 1969
ABST A completed study to determine whether production losses have occurred in the remaining stand as a result of various kinds of mechanical damage caused by wheeled tractors in the course of logging operations is discussed.
KEYW Damage, growth and yield, machinery

232 AUTH Hedin, I.B.
TITL Lodgepole pine stand descriptions for strip thinning machine development.
PUBL Tech. Note TN-89. Vancouver, B.C., Canada: Forest Engineering Research Institute of Canada. 4 p.
YEAR 1986
ABST Descriptions are given of target stand characteristics for the mechanization of thinning in young (10- to 15-year-old) stands and in older (15- to 40-year-old) stands of logging or wildfire origin together with discussion of how the results of this study can help equipment designers.
KEYW Damage, selective thinning, site

233 AUTH Heikuraninen, L.; Paivanen, J.
TITL The effect of thinning, clearcutting, and fertilization on the hydrology of peatland drained for forestry.
PUBL Acta Forestolia Fennica. 23 p. Vol. 104.
YEAR 1970
ABST The objective of this study was to determine the effect of various cutting intensities on the ground water level in drained peatlands. The results show that cutting influences the rise of water level. High thinning intensity raised the water level by reducing transpiration by interception. Runoff is greater from areas with a high ground water level than from areas with a low ground water level. The rise of water level caused by cutting, therefore, depends not only on the cutting intensity but also on the intensity of drainage.
KEYW Clearcut, fertilization, silviculture

234 AUTH Heist, L.C.
TITL The place of thinning in southern forestry--an overview.
PUBL In: Thinning southern pine plantations: Proceedings of southern forest economics workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 1-17.

YEAR 1980
ABST Growth of the plywood and lumber industry is discussed together with the South's future dependence on softwood from plantation. The author notes that pine pulpwood price has declined and sawtimber price has increased in real terms, and includes estimates of number of trees per acre and feet per acre thinned and unthinned.
KEYW Economics, forecasts, growth and yield, loblolly, plantation, slash pine, South, spacing

235 AUTH Hensel, J.S.
TITL Equipment configuration prospects for thinning plantations.
PUBL APA Tech. Rel. 80-R-77. Washington, DC: American Pulpwood Association. 24 p.
YEAR 1977
ABST Theoretical configuration and functions are presented for a specific type of harvesting equipment that performs thinning.
KEYW Machinery, plantation

236 AUTH Hensel, J.S.
TITL Timbco hydro buncher.
PUBL APA Tech. Rel. 80-R-58. Washington, DC: American Pulpwood Association. 4 p.
YEAR 1980
ABST Report on a tracked machine that can fell, delimb, and bunch whole trees, cut two trees per minute, and operate on steeper slopes than most conventional equipment.
KEYW Bunching, feller-buncher, felling, limbing, machinery

237 AUTH Hickman, C.A.
TITL How to evaluate timber investment opportunities.
PUBL Forest Industries. 113(2): 20-23.
YEAR 1986
ABST Thinning analysis of plantation management is discussed.
KEYW Economics

238 AUTH Hillstrom, W.A.; Steinhilb, H.M.
TITL Mechanized thinning shows promise in northern hardwoods.
PUBL The Northern Logger and Timber Processor. 24(12): 12-13, 32.
YEAR 1976
ABST In a study to investigate the profit possibilities when thinning a Northern hardwood pole timber stand with a mechanized logging system, strip-plus-selection thinning proved most promising after paying all costs. A $125-per-acre profit may be realized with this method when felling, skidding, chipping, and delivering to the mill, material normally considered thinning residue. Injury to the remaining stand was more severe than is found in a chain saw thinning (timber stand improvement), but it was not unreasonable.
KEYW Damage, economics, machinery, selective thinning, strip thinning, systems

239 AUTH Hilt, D.E.
TITL Diameter growth of upland oaks after thinning.
PUBL Res. Pap. NE-437. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 12 p.
YEAR 1979
ABST Diameter growth rates of the 40 largest trees per acre on 154 permanent plots in Kentucky, Ohio, Missouri, and Iowa were analyzed to determine the effects of thinning in upland oak stands. The plots were established over a wide range of stocking levels, stand age, and site conditions. Thinning resulted in increased diameter growth of the residual trees, regardless of age or site. The heavier the thinning, the greater the response. Diameter growth rates, and growth response after thinning relative to a control, were better in younger stands. Growth rates were higher on better sites, but the growth response relative to a control was not influenced much by site. In most instances, the largest 40 trees per acre responded as well or better to thinning than the second 40 largest.
KEYW Growth and yield, hardwood

240 AUTH Hilt, D.E.; Dale, M.E.
TITL Stem form changes in upland oaks after thinning.
PUBL Res. Pap. NE-433. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 7 p.
YEAR 1979
ABST Results of two independent studies were analyzed to determine whether residual stocking after thinning had any effect on change in stem form of upland oak. Neither study showed significant differences in stem form changes that could be related to residual stocking. The change in stem form was significantly correlated with the initial form for all stocking levels. Trees with the best form were more likely to deteriorate in form while the poorly formed trees were most likely to improve, regardless of the residual stocking level.
KEYW Damage, hardwood

241 AUTH Hodges, C.S., Jr.
TITL Symptomatology and spread of Fomes annosus in southern pine plantations.
PUBL Res. Pap. SE-114. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 10 p.
YEAR 1974
ABST Examination of 0.1-acre study plots established in plantations of slash pine and loblolly pine in South Carolina and Georgia showed that the number of trees infected by Fomes annosus in a center of infection increased for the first 4 to 8 years after thinning (at ca. 15 years) and decreased thereafter. On high-hazard sites, most infected trees died before any progressive crown symptoms or conks developed. This tendency, coupled with the facts that only a few trees die in each center during a year and that centers are usually scattered through the plantation, make salvaging of dead or infected trees difficult. Notes are included on resinosis of bark and wood, barkbeetle attack, natural regeneration in disease centers, root symptoms, and windthrow.
KEYW Diseases, loblolly, plantation, slash pine, South

242 AUTH Hoffman, B.F.
TITL Precommercial thinning.
PUBL Journal of Forestry. 85(3): 16-18.
YEAR 1987
ABST This article discusses economic values of precommercial thinning.
KEYW Economics, precommercial thinning, silviculture

243 AUTH Hoffman, B.F.
TITL Skidding with small tractors.
PUBL The Northern Logger and Timber Processor.28(10): 18-20.
YEAR 1980
ABST A method of skidding is described using an agricultural tractor with a Farmi JL-25 winch mounted on the three-point hitch. Production data for tree-length skidding are given. The method is also used for shortwood bunching. Suggestions are given for minimizing damage when skidding with a small tractor.
KEYW Bunching, damage, machinery, Northeast, shortwood, skidder

244 AUTH Hoffman, B.F.; Wedge, D.C.; Gadzik, C.J.
TITL Scandinavian thinning techniques in a natural Northeastern softwood stand.
PUBL Northern Journal of Applied Forestry. 4(1): 38-42.
YEAR 1987
ABST The applicability of Scandinavian thinning techniques to small-diameter Northeastern softwood stands was tested. Cutting used motor manual techniques in which the cutter felled, limbed, bucked, and piled 8-foot bolts for extraction to trailside by a small tractor and winch. Sixteen-foot lengths were also cut in order to compare the relative merits of the two sizes. It was determined that costs are unacceptable, but the technique may be viable for woodlot owners with limited equipment and low wage requirements.
KEYW Cable system, equipment, Northeast

245 AUTH Hoffman, R.E.; Lanford, B.L.; Iff, R.H.
TITL Evaluation of the Holder A55 logging tractor.
PUBL Bull. 539. Auburn, AL: Alabama Agricultural Experiment Station, Auburn University. 33 p.
YEAR 1982
ABST Objectives of the study were (a) to determine productivity of a holder A55 as a skidder, (b) to evaluate environmental effects on productivity, (c) to compare the actual performance of the machine to performance predicted by a model, (d) to investigate alternate hooking equipment and estimate changes in productivity resulting from use of alternate equipment, (e) to analyze operating cost for machine, relate cost to production, and estimate changes in cost associated with alternate hooking equipment.
KEYW Economics, equations, machinery, models, skidder

246 AUTH Holemo, F.
TITL Site preparation methods for regenerating southern pines.

PUBL Circ. ANR-275. Auburn, AL: Alabama Cooperative Extension Service, Auburn University. 4 p.
YEAR 1984
ABST Mechanical, chemical, and prescribed burning as tools for site preparation are discussed.
KEYW Clearcut, hardwood, site

247 AUTH Horne, R.; Robinson, G.; Gwalter, J.
TITL Response increment: a method to analyze thinning response in even-aged forest.
PUBL Forest Science. 32(1): 243-253.
YEAR 1986
ABST Response of basal area growth to density changes is examined by partitioning increment from ranked strata within a stand into increment that is dependent on density change and that which is not. This allows resolution of the curve of total increment against density into a number of definite and recognizable segments. The partitioned increment/stocking relations are found to be closely approximated by modified Wiebull density and distribution functions.
KEYW Growth and yield

248 AUTH Howard, T.E.
TITL An economic model for thinning natural stands of Eastern white pine.
PUBL In: New forests for a changing world; Proceedings of the 1983 convention of the Society of American Foresters; 1983 October 16-20; Portland, OR. Bethesda, MD: Society of American Foresters. [Number of pages unknown].
YEAR 1983
ABST Extensive acreage of slash pine plantations in the Southeast are infected with fusiform rust and other diseases resulting in lost growth. A scheduling model for optimal thinning and final harvest is to assist in stand management, and it should allow for disease infection and growth losses affecting the marginal value growth of the stand. A dynamic simulation model incorporating an individual tree/distance-dependent growth model can be utilized to develop alternative management strategies correlated to a level of disease infection and its special distribution.
KEYW Economics, harvester, methods, models

249 AUTH Hughes, E.L.
TITL Regeneration after logging in the maritime provinces.
PUBL Pulp and Paper Magazine of Canada. 71(10): 73-78.
YEAR 1970
ABST A review of regeneration surveys in the maritime provinces indicated tolerable levels of stocking and number per acre after most kinds of logging operations including tree-length, wheeled skidder, and full-tree systems. However, most new stands are either too dense or have unstocked and poorly stocked portions, and in many, the species and species-mixes of the new stands are undesirable. Large-scale application of silvicultural treatments such as cleaning, thinning, planting, and fertilizing are recommended to increase production of usable wood and reduce future harvesting costs. Such treatments are essential to meet future demand for wood.
KEYW Damage, silviculture, site, systems

250 AUTH Hughes, J.H.; Herschelman, J.W.
TITL Density regulation--the plantation thinning equation.
PUBL In: Proceedings of the symposium on the loblolly pine ecosystem (West region): 1984 March 20-22; Jackson, MS. [Place of publication unknown]: [Publisher unknown]. [Number of pages unknown].
YEAR 1984
ABST Plantation thinning is the silvicultural treatment used to reallocate growth potential to selected crop trees and to maintain a healthy, vigorous stand. This forest management practice can increase net revenue by enhancing quality sawtimber production in the final crop. However, the real world makes thinning a complex issue. Market economics, silvicultural requirements, thinning equipment limitations and plantation, soil, and topographic characteristics are variables in the plantation thinning equation that determine if, when, and how to thin each particular stand.
KEYW Clearcut, diseases, loblolly, machinery, plantation, precommercial thinning, row thinning, selective thinning, silviculture, site, strip thinning, volumes

251 AUTH Hull, R.B., IV; Buhyoff, G.J.
TITL The scenic temporal distribution method: an attempt to make scenic beauty assessments compatible with forest planning efforts.
PUBL Forest Science. 32(2): 271-286.
YEAR 1986
ABST Regression analysis was used to determine the effects of initial stand density, site index, and rotation length on the scenic beauty of four management practices in loblolly pine. Natural stands were of the highest scenic quality; lightly thinned plantations were the least scenic. In general, scenic beauty increased with decreasing initial stand density and site productivity and increasing stand age.
KEYW Natural stand

252 AUTH Hunt, F.M.; Mader, D.L.
TITL Low density management--a means to increase timber yields while using less soil moisture.
PUBL Bull. 588. Amherst, MS: Massachusetts Agricultural Experiment Station, University of Massachusetts.24 p.
YEAR 1970
ABST A thinning experiment in two 22-year-old white pine stands involved removal of either 81 or 30 percent of the basal area on treated plots. Over a 6-year period, diameter growth of selected crop trees was more on treated plots than on control plots by 230 percent and 70 percent, respectively. A growth response was observed in the first season after thinning. The heavily thinned plots had more available moisture in the 30-inch soil profile during late season droughts and continued growth later in the season. Heavy thinning appeared to increase tree growth and accelerate timber yield while conserving soil moisture.
KEYW Growth and yield, plantation, site

253 AUTH Hutte, P.
TITL Investigations concerning the influence of thinnings on the resistance of spruce stands against winds.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 158-162.
YEAR 1969
ABST Information collected on swaying of spruce depending on thinning grade, soil, wind conditions, and wet soil is given.
KEYW Damage, site

254 AUTH Huyler, N.K.; Koten, D.E.; Lea, R.V.; Quadro, A.P.
TITL Productivity and cost of three small fuelwood skidders.
PUBL Journal of Forestry. 82(11): 671-674.
YEAR 1984
ABST Three small 4-wheel-drive tractors were tested for suitability for skidding mixed hardwood fuelwood from a thinned stand in New York. The equipment used was: a 993 Pasquali 30-horsepower diesel with a Farmi JL-25 single-drum winch; an A-60 Holder 48-horsepower diesel with an Igland 3000 double-drum winch; and a Forest Ant 12-horsepower, air-cooled four-stroke engine with a clam bunk, and a knuckleboom loader with a jaw grapple. Each machine was compared with others as to production and operating cost.
KEYW Biomass, economics, equipment, hardwood

255 AUTH Hyland, J.; Kucera, B.
TITL Southern pine beetle and annosus root rot management.
PUBL Alabama's Treasured Forests. 4(1): 17-19.
YEAR 1985
ABST The authors discuss how to recognize the symptoms of southern pine beetle attack and annosus root rot infection, and how thinning can reduce the risks of attack or infection.
KEYW Damage, diseases, silviculture, South

256 AUTH Hypes, T.L.
TITL The relationships between tree size, harvesting cost, and productivity: summary and conclusions.
PUBL APA Tech. Pap. 79-P-30. Washington, DC: American Pulpwood Association. 3 p.
YEAR 1979
ABST Using simulation methods, this study of the impact of tree size on production and cost of harvesting in the South was restricted to the analysis of longwood systems in clearcut harvesting of natural and plantation pine stands. Tree size was found to have a significant impact on harvesting productivity.
KEYW Bunching, economics, feller-buncher, longwood, processing, skidder, South, systems

257 AUTH Hypes, T.L.; Stuart, W.B.
TITL Preliminary analysis of harvesting cost by diameter class questionnaire.

PUBL Blacksburg, VA: School of Forestry and Wildlife Resources, Industrial Forestry Operations, Virginia Polytechnic Institute and State University. 43 p. [Rough draft].
YEAR [Year unknown]
ABST Graphs show time per tree plotted against d.b.h. for felling; limbing and topping; limbing, topping and bucking; bucking; hand piling; shortwood processing; knuckleboom loading; big stick loading at the deck and in the woods. Also given aresummaries of cost information regarding labor rate, woods equipment, trucking, and data on machine availability.
KEYW Chipping, economics, feller-buncher, forwarder, labor, loading, machinery, skidder

258 AUTH Ievin, I.K.; Kazhemak, A.J.; Mezhal, J.V.
TITL Logging techniques in thinning today and tomorrow in the USSR.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 85-86.
YEAR 1969
ABST A fully mechanized logging system for thinnings is being developed and introduced in the Soviet Union. The project is still at the prototype stage, but the system is expected to have widespread application in the future. The system is based on selective thinning, using strip-roads 2.5 to 3 meters wide at 10-meter intervals in young stands and at 20 meter intervals in older stands, the same strip-roads being used during the whole lifetime of the stand. The key machine is the Dyatel (the Woodpecker) which can be used as a feller-buncher or feller-skidder. The Dyatel-L is constructed for work in young stands, and it can take trees with maximum stump diameter of 18 centimeters and maximum weight of 200 kilograms. The corresponding figures for Dyatel-2, which is designed for work in older stands, are 42 centimeters and 800 kilograms.
KEYW Feller-buncher, machinery, methods, selective thinning, skidder, strip thinning, systems

259 AUTH Izlar, B.
TITL Farmi JL 456 skidding winch.
PUBL APA Tech. Rel. 84-6-24. Washington, DC: American Pulpwood Association. 1 p.
YEAR 1984
ABST Specifications, cost, and operation of the Farmi JL 456 skidding winch are described. Winch can be attached to the three-point hitch of any medium-size farm tractor and is ideal for select cutting on small woodlots and plantation thinnings.
KEYW Machinery, skidder

260 AUTH Izlar, B.
TITL Rome high speed shear operating in east-central Mississippi.
PUBL APA Tech. Rel. 80-R-21. Washington, DC: American Pulpwood Association. 1 p.
YEAR 1980
ABST Mechanical arms grab and pull the tree into shear blades of the machine that can shear and accumulate trees with an average butt diameter of 15 to 18 inches. An average of 75 cords per day can be cut in natural stands with an average d.b.h. of 8 inches.
KEYW Feller-buncher, machinery

261 AUTH Izlar, B.; Domenech, D.; Czerepinski, F.P.; Stokes, B.J.
TITL Makeri 33T harvester.
PUBL APA Tech. Rel. 83-R-14. Washington, DC: American Pulpwood Association. 3 p.
YEAR 1983
ABST Features, applications, specifications, and cost of Makeri 33T harvester are given, and production and time studies are reported.
KEYW Feller-buncher, harvester, machinery, processor

262 AUTH Izyumskii, P.P.
TITL Thinning in young hardwoods using new technology.
PUBL Lesnoe Khozyaistvo. 12: 19-23.
YEAR 1984
ABST A review of Russian experience with the thinning of young oak plantations and recommendations is presented. Recommendations are made on the organizational and technical aspects of mechanized thinning.
KEYW Hardwood, harvester, selective thinning

263 AUTH Jackson, B.D.; Hackfield, M.C.; Jenkins, M.W.
TITL Using a Makeri harvester to thin a natural loblolly pine stand for the first time.
PUBL Southern Journal of Applied Forestry. 8(3): 132-135.
YEAR 1984
ABST The Makeri, a small tracked harvester, was performance tested in the first commercial thinning of a 14-year-old natural loblolly pine stand in the flatwoods of Louisiana. Productivity of the machine was studied in winter conditions on wet, poorly drained soils. Results from work sampling and a time study indicated a 73-percent utilization rate and an hourly output of 45.9 trees or 88.1 cubic feet.
KEYW Damage, harvester, loblolly, machinery, natural stand, selective thinning, South, strip thinning,

264 AUTH Jackson, B.D.; Schmitt, W.R.
TITL Specific equipment needs and potential for development.
PUBL In: Thinning southern pine plantations: Proceedings of forest economic workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 92-103.
YEAR 1980
ABST Specific equipment needs depend on company objectives. The analytical tools used in establishing a system and the potential for developing new machines for thinning are discussed. Effects on time, cost, labor, and markets of making design changes in a machine are reviewed.
KEYW Economics, labor, machinery, South, systems

265 AUTH Jackson, L.W., Jr.
TITL Growth of unthinned loblolly, slash, and longleaf pine plantations in Georgia.
PUBL Pap. 63. Macon, GA: Georgia Forest Research. 11 p.

YEAR 1970
ABST Data on stem growth are given in terms of basal area increment. Types of tree were dominant for longleaf, intermediate or dominant for slash and loblolly. Ages were 25 for loblolly, 28, 33, and 36 for longleaf, and 28 for slash.
KEYW Growth and yield, loblolly, longleaf, plantation, slash pine, South

266 AUTH Johnson, J.A.; Hillstrom, W.A.; Miyata, E.S.; Shetron, S.G.
TITL Strip selection. Method of mechanized thinning in northern hardwood pole-size stands.
PUBL The Northern Logger and Timber Processor. 28(11): 26-27, 58-60.
YEAR 1980
ABST To determine the economic and silvicultural implications of a mechanized harvesting system, strips were thinned from a basal area in Michigan of 116 square feet to 68 square feet per acre.
KEYW Chipping, damage, economics, feller-buncher, machinery, methods, selective thinning, skidder, strip thinning, systems

267 AUTH Johnson, L.R.
TITL Production of wood from precommercial thinning: a cost assessment.
PUBL ASAE Pap. 77-1573. St. Joseph, MI: American Society of Agricultural Engineers. 24 p.
YEAR 1977
ABST Economic incentive for recovery of the material produced during precommercial thinning does not exist under current market conditions when conventional harvesting systems are used for recovery. The most significant lack is a skidding system that can efficiently handle small, scattered material. The cost revenue comparison made here does not include any allowance for the reduction in fire and disease hazard achieved by removing the thinned material. If these risks are high enough, then the extra cost incurred in material recovery may be justified.
KEYW Chipping, diseases, economics, precommercial thinning, skidder, systems

268 AUTH Jonas, A.
TITL Wood chip production in combination with stand tending.
PUBL Holz-Zentralblatt. 110(21): 313-314.
YEAR 1984
ABST A selective thinning operation was conducted in two Norway spruce stands. A 17-year-old stand was thinned, and severed stems were left leaning on stems in the remaining stand. A 22-year-old stand was thinned, trimmed, and stored in stacks outside to dry. The latter gave better results indicating that stems should be felled in late autumn or winter, stored until the following late summer, and then chipped.
KEYW Chipping, felling, selective thinning, silviculture

269 AUTH Jones, E.P., Jr.
TITL Precommercial thinning for slash and loblolly pines.
PUBL In: Proceedings of symposium on management of young pines; 1974 December 3-5; Charleston, SC. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 229-233.

YEAR 1974
ABST Precommercial thinning by age 5 is recommended for overstocked slash and loblolly pine stands. Overstocking is not precisely defined in the research literature, and threshold values range from 1,500 to 5,000 stems per acre. Residual densities of 500 to 750 trees per acre are recommended. Selected studies of slash and loblolly pines show volume gains of 4.5 cords per acre and more after 12 to 15 years. Such increases easily justify the cost of mechanical precommercial thinning.
KEYW Growth and yield, loblolly, precommercial thinning, slash pine

270 AUTH Jones, E.P., Jr.
TITL Precommercial thinning of naturally seeded slash pine increases volume and monetary returns.
PUBL Res. Pap. SE-164. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 12 p.
YEAR 1977
ABST A naturally seeded slash pine stand with up to 50,000 stems per acre was precommercially thinned at age 3. Two methods leaving either single trees or clumps of six to eight trees spaced 10 by 10 feet apart were compared with an unthinned original stand. After 20, the single-tree and clump plots had substantially more commercial volume than the unthinned plots. Such gains in commercial volumes can justify a sizable investment in precommercial thinning. Thinning by age 5 to less than 1,500 trees per acre is recommended. Growth in diameter and height was inversely related to stand density. Thus adjustments for trees per acre may be needed when evaluating or comparing slash pine site indexes over a broad range of densities.
KEYW Economics, growth and yield, natural stand, precommercial thinning, slash pine, South

271 AUTH Jones, S.B.; Broerman, F.S.
TITL Thinning and fertilization of sixteen-year-old loblolly pine.
PUBL Res. Note 34. Macon, GA: Woodlands Research Department. 2 p.
YEAR 1977
ABST Stand characteristics are tabulated for a lowland plantation of loblolly pine in North Carolina before treatment in 1973 and 4 years later. Thinning (selective removal of about 40 percent of the basal area) and NPK fertilizing, separately or combined, caused gains in height and d.b.h. increment (over controls) that were nearly additive in the combined treatment.
KEYW Fertilization, growth and yield, loblolly, plantation, selective thinning, South

272 AUTH Kammenga, J.J.
TITL Whole-tree utilization system for thinning young Douglas-fir.
PUBL Journal of Forestry. 81(4): 220-224.
YEAR 1983
ABST The Washington State Department of Natural Resources is commercially thinning naturally established 40-year-old Douglas-fir stands that were once considered too small to be merchantable. Efficient, cost-effective thinning is accomplished by whole-tree chipping in the woods. The logging system includes a portable chipper, a chain-flail delimber, two

rubber-tired grapple skidders, and three rubber-tired or tracked tree-to-tree feller-bunchers with accumulators. This system provides total utilization of the harvested material. An average of 100 to 125 green tons of pulp chips with less than 7-percent bark can be produced in an 8-hour shift. Approximately 1,000 stems per acre, averaging 4 inches in diameter at breast height, are removed to leave 200 of the best trees. This stocking gives adequate growing space and provides operational maneuverability. The feller-buncher operators are trained to select trees by following rules that describe leave trees. Stand damage can be kept within acceptable limits, preferably under 5 percent of the leave trees, by requiring prelocated skid trail systems and rub trees. Successful tree selection and avoidance of stand damage depend upon operator cooperation.

KEYW Chipping, damage, feller-buncher, machinery, processing, skidder, systems, West, whole-tree

273 AUTH Karkkainen, M.
TITL A study of tree injuries caused by mechanized timber transportation.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 136-140.
YEAR 1969
ABST Statistics are given on trees damaged during mechanized transportation.
KEYW Damage, equations, machinery

274 AUTH Keister, T.D.; Crow, A.B.; Burns, P.Y.
TITL Results of a test of classical thinning methods in a slash pine plantation.
PUBL Journal of Forestry. 66(5): 409-411.
YEAR 1968
ABST Results of a thinning experiment that compared four European thinning methods and unthinned control, initiated in a 13-year-old slash pine plantation in Louisiana, were studied over a 27-year period. The greatest net growth was made by the lightly thinned plots. Average stand diameter was increased by thinning, but thinning had no appreciable effect on the height of the dominant stand. Thinning resulted in trees with slightly less taper and fewer knots on the butt log but did not affect the specific gravity of the outermost 10 growth rings or the proportion of pole and piling trees. Thinning was financially advantageous.
KEYW Economics, growth and yield, plantation, South

275 AUTH Keister, T.D.; McGriff, J.A.
TITL Thinning dense young loblolly pine stands with a granular herbicide.
PUBL Forestry Note 107. Baton Rouge, LA: Louisiana State University. 4 p.
YEAR 1974
ABST Tordon 10k (= picloram) in pelleted form was applied at rates of 10, 20, or 40 pounds per acre in strips through a dense stand of 3-year-old seedlings of loblolly pine. It reduced the stocking significantly, but insufficiently for the young trees in the untreated strips to show a rapid response. The applications affected height growth in the untreated strips to a small extent, but caused deaths among the widely spaced seed-trees in the overwood. The authors suggest that the

treatment might have been more effective if it had been applied when the seedlings were younger.

KEYW Chemicals, loblolly, precommercial thinning, South, strip thinning

276 AUTH Kellison, R.C.; Gingrich, S.

TITL Loblolly pine management and utilization--state of the art.

PUBL Southern Journal of Applied Forestry. 8(2): 88-96.

YEAR 1984

ABST A summary is given of topics discussed at the symposium on the loblolly pine ecosystem (East region) held in Raleigh, NC, on December 8-10, 1982. The east region comprises Virginia, North Carolina, South Carolina, Georgia, and Florida. A second symposium is scheduled for spring 1984 to cover the remaining natural range of loblolly pine. Plantations constitute about 27 percent of the loblolly pine resource of the East region, about two-thirds of the area belonging to forest industry. Natural stands can be established for about one-third the cost of plantations, where plans are made for natural regeneration. Optimal value is realized from plantations where site preparation is complete and where pests, competing vegetation, and stocking are controlled. Genetically improved planting stock, fertilization, and thinning are integral parts of plantation forestry. Maintaining site productivity is one of the greatest challenges facing the forest industry.

KEYW Damage, diseases, growth and yield, loblolly, machinery, plantation, silviculture

277 AUTH Kellog, L.D.

TITL Thinning young timber stands in mountainous terrain.

PUBL Res. Bull. 34. Corvallis, OR: Oregon State University, School of Forestry. 17 p.

YEAR 1980

ABST The Forest Engineering Department has evaluated systems for thinning young timber stands on steep terrain. Research findings from 1972 to 1979 are discussed on felling and bucking as well as yarding. Felling and bucking production increased with thinning intensity. Tractor yarding production decreased with steeper slopes. Total skyline logging cost from 1.5 to 1.67 times as much as tractor logging on slopes up to 40 percent. Removing prebunched logs to the skyline corridor increased yarding production.

KEYW Bunching, cable system, economics, felling, juvenile wood, processing, skidder, steep slopes, systems

278 AUTH Kerruish, C.M.

TITL Harvesting in Australian radiata pine plantations: current practice and future development.

PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 87-88.

YEAR 1969

ABST Manual short-wood systems predominate today. Mechanization is increasing and tree length harvesting is gaining acceptance. Selective thinnings are the usual method.

KEYW Forwarder, machinery, plantation, processor, radiata pine, row thinning, selective thinning, shortwood, skidder, systems

279 AUTH Kerruish, C.M.
TITL Technological developments relevant to the thinning of plantations.
PUBL In: Norwegian IUFRO Congress Committee: Proceedings of XVI IUFRO World Congress; Division III; 1976 June 20-July 2; Oslo, Norway: International Union of Forestry Research Organization: 330-340.
YEAR 1976
ABST This author reviews progress during the past three years in the mechanization of plantation thinning operations in Australia. Significant developments include the introduction of fully mechanized row harvesting equipment, some exploratory trials with various feller-bunchers and a processor, and the development and introduction of a means of mechanizing the selective removal of unwanted stems in noncommercial thinning operations. However, it is estimated that not more than 2 to 3 percent of the 1977 early thinning cut will be made with such tools. There is recognition of the need to train the cutter work force. Forwarders are now the main means of transporting wood to roadside.
KEYW Feller-buncher, felling, forwarder, harvester, machinery, plantation, precommercial thinning, processor, pruning, row thinning, selective thinning, shortwood, systems, training

280 AUTH Kerruish, C.M.
TITL Thinning techniques applicable to radiata pine plantations.
PUBL New Zealand Journal of Forestry Science. 6(2): 200-213.
YEAR 1976
ABST A review is given of the various thinning methods and equipment available to the forest manager for a range of silvicultural practices, including thinning to waste. Considerable increases in the productivity of conventional chain saw based techniques have been obtained by variations of wood specification, the introduction of forwarders for extraction, and the training of the cutter force. The introduction of more mechanized techniques has commenced but acceptance has been slow. Mechanization of early thinnings is considered most likely to be economical under favorable stand treatment and terrain conditions where simpler and less costly machines can be used. The mechanization of these operations can be facilitated by increasing the stem size of the trees by reducing wood specification to permit multiple stem harvesting.
KEYW Cable system, chipping, feller-buncher, felling, forwarder, harvester, machinery, plantation, precommercial thinning, processing, processor, row thinning, selective thinning, skidder, systems

281 AUTH King, A.L.
TITL Measuring soil compaction in mechanically thinned pine plantations.
PUBL ASAE Pap. 79-1600. St. Joseph, MI: American Society of Agricultural Engineers. 8 p.
YEAR 1979
ABST Samples showed that soil did not compact in four of six sites where five different machines had thinned pine plantations. The author concludes

that use of heavy machinery in tree harvesting does not harm forest soil.

KEYW Damage, machinery, plantation, site

282 AUTH King, A.L.; Haines, S.G.

TITL Soil compaction absent in plantation thinning.

PUBL Res. Note SO-251. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 4 p.

YEAR 1979

ABST A TH-105 thinner harvester used with two forwarders to thin a slash pine plantation caused no detectable soil damage. Moderate ground pressure together with the distribution of branches on the soil in front of the machine contributed to the absence of soil compaction. The Troxler 3411 nuclear moisture density meter consistently overestimated soil moisture by 3 to 5 percent and underestimated soil bulk density by 0.3g/cc (18.7 lb/ft) compared to the gravimetric method.

KEYW Damage, forwarder, harvester, machinery, plantation, site, slash pine, South

283 AUTH King, J.E.

TITL The development and status of thinning in Douglas-fir forests of the Pacific northwest.

PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].

YEAR 1977

ABST The historical development of research and practice in thinning Douglas-fir is summarized. A background and current status of thinning as practiced in the Pacific northwest is provided.

KEYW Selective thinning, West

284 AUTH Kirk, D.G.; Breeman, L.G.; Zobel, B.J.

TITL A pulping evaluation of juvenile loblolly pine.

PUBL Tappi. 55(11): 1600-1604.

YEAR 1972

ABST Summary of the results of several general studies on pulping juvenile wood (which has unique properties that could prove useful in the manufacture of various special products). A specific study on wood of 12-year-old loblolly pine trees selected for low, average, and high specific gravity is described. The short, thin-walled traceids of juvenile wood produced pulp of unusually high tensile and burst strength, fold endurance, apparent density and smoothness of sheet surface, and unusually low tear strength and capacity. The low specific gravity of the wood and low pulping yield restrict mill output and impose higher manufacturing costs. Young thinning and clearfelled young plantation crops are the only practical sources of juvenile pine at present available. Clearfelling of young plantations results in less wood volume per cord and in greatly increased harvesting costs per cord or per ton of wood, while the low pulp yield (which is equally poor whether based on dry weight, wet weight, or volume) adds considerably to the amount of wood required to produce a ton of pulp. The manufacturing cost of a ton of juvenile wood is estimated to be 65 percent more than

that of a ton of mature wood, most of the cost differential resulting from the higher cost of the wood.
KEYW Economics, juvenile wood, loblolly, pulpwood, silviculture, South

285 AUTH Klemperer, W.D.
TITL Economic analysis applied to forestry: does it short-change future generations?
PUBL Journal of Forestry. 74(9): 609-611.
YEAR 1976
ABST When it is desired to allocate use of resources over time, an interest rate performance indicator can help determine an optimal mix of outputs without maximizing any particular one.
KEYW Economics, forecasts

286 AUTH Klemperer, W.D.
TITL Inflation and present value of timber income after taxes.
PUBL Journal of Forestry. 77(2): 94-96.
YEAR 1979
ABST Where a guiding rate of interest fluctuates with the inflation rate but remains constant in real terms, present values of future timber income after property taxes or yield taxes tend to be independent of inflation. After capital gains taxes, however, present values decline with increases in the projected inflation rate. The decline becomes less significant with lengthening payoff periods.
KEYW Economics

287 AUTH Kluender, R.A.
TITL Farmi JL-45 skidding winch.
PUBL APA Tech. Rel. 76-R-54. Washington, DC: American Pulpwood Association. 2 p.
YEAR 1976
ABST Description of the Farmi JL-45 and JL-30 winches which can be attached to the three-point hitch of any suitably large tractor and used for skidding, together with specification, cost, and method of operation.
KEYW Machinery, skidder, South

288 AUTH Kluender, R.A.; Pennanen, O.H.
TITL The use of a small agricultural tractor in plantation thinnings.
PUBL Blacksburg, VA: Virginia Polytechnic Institute and State University, Department of Forestry, Industrial Forestry Operations. [Number of pages unknown].
YEAR [Year unknown]
ABST Small agricultural tractors may be viable alternative tools for use in plantation thinnings in which larger equipment may injure the remaining trees and involve high fuel costs. A Kubota 295DL with a winch attached to the three-point hitch was the basic tractor tested in this study. Productivity of the skidder is given and the operation analyzed.
KEYW Machinery, plantation, skidder, South

289 AUTH Knight, D.K.
TITL Thinning challenge untangled.
PUBL Timber Harvesting. 34(12): 32-34.
YEAR 1986
ABST Author describes a plantation thinning crew, their methods and equipment.
KEYW Economics, equipment, feller-buncher, skidder

290 AUTH Knight, H.A.; McClure, J.P.
TITL Opportunities for increasing timber supplies in the Southeast.
PUBL Resour. Bull. SE-28. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 7 p.
YEAR 1974
ABST The role of thinning in slash pine plantations, thinning in natural stands, and the importance of early thinning is given.
KEYW Natural stand, plantation, precommercial thinning, slash pine, South, spacing

291 AUTH Knight, H.A.; Sheffield, R.M.
TITL Thinning opportunities in pine plantations in the Southeast during the 1980's.
PUBL In: Thinning southern pine plantations: Proceedings of southern forest economics workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 18-26.
YEAR 1980
ABST Approximately one-third of the pine stands in the Southeast are plantations. Fifty-nine percent are in Florida and Georgia, 50 percent of which are owned by industry. An increase in commercial thinning is reported. Comparisons are made of each state with each of the other Southeastern States.
KEYW Loblolly, plantation, site, slash pine, South, volumes

292 AUTH Knoebel, B.R.; Burkhart, H.E.; Beck, D.E.
TITL A growth and yield model for thinned stands of yellow poplar.
PUBL [Forest Science Monograph] (27):62. Bethesda, MD: Society of American Foresters. 41 p.
YEAR 1986
ABST The model, which produces estimates of number of stems, basal area, and volume per acre by stand and diameter class, can be used to predict growth and yield of future stands.
KEYW Growth and yield, selective thinning, volumes

293 AUTH Knutell, H.; Sundin, T.
TITL Felling and bunching small trees from thinnings with small scale equipment.
PUBL Project IEA-FE-PCG-CPC7. [Place of publication unknown]: Institutionen for Skogsteknik. [Number of pages unknown].
YEAR 1982
ABST Swedish thinning stands and their needs are described, and ownership of Swedish forest lands is specified. Current Swedish thinning systems, problems, current research and developments, as well as future research and development plans, are described.

KEYW Feller-buncher, harvester, machinery, processor, systems

294 AUTH Knutson, D.; Tinnin, R.
TITL Effects of dwarf mistletoe on the response of young Douglas-fir to thinning.
PUBL Canadian Journal of Forest Research. 16(1): 30-35.
YEAR 1986
ABST Trees with light infections showed a significant increase in radial increment after thinning whereas more heavily infected trees did not.
KEYW Damage, West

295 AUTH Koch, P.
TITL Concept for southern pine plantation operation in the year 2020.
PUBL Journal of Forestry. 78(2): 78-82.
YEAR 1980
ABST Fertilization, close spacing, very early thinning, and application of new harvesting and manufacturing technology over a 35-year rotation could yield 146 tons per acre (ovendry basis) of pulp, 2-by-4 studs, random-length conventional lumber, millwork and structural laminated wood, long-wide structural lumber laminated from veneer, sheathing plywood, structural flakeboard, and animal food supplement (muka). At $200 per product ton (ovendry basis, 1979 dollars), each acre could yield a gross realization of about $29,200 from these products per 35-year rotation; additionally, about 47 tons (ovendry basis) of fuel would be harvested over the 35-year rotation.
KEYW Economics, fertilization, forecasts, plantation, pulpwood, South, spacing

296 AUTH Kramer, H.
TITL Existing and planned growth and yield experiments with the purpose to rationalize the management of Norway spruce.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 232-235.
YEAR 1969
ABST The aim of the experiments presented is to determine optimal financial yield and safety of the stands. Planting, cleaning, and thinning are also emphasized.
KEYW Growth and yield, row thinning, selective thinning

297 AUTH Kramer, H.
TITL Some experience in Norway spruce thinning in the Federal Republic of Germany.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting: 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST From the silvicultural point of view, thinning is very important in young, dense Norway spruce stands. The author deals with different selective and geometrical treatments in first thinning of spruce. Regarding biological, technical, and economical aspects, a combined

geometrical (strip or line) thinning and selective crown thinning is recommended for the first thinning.

KEYW Precommercial thinning, selective thinning, silviculture, strip thinning

298 AUTH Krogstad, I.

TITL Felling and bunching small trees from thinning with small scale equipment. Status and planning report.

PUBL Project IEA-FE-PGC-CPC7. Vollebekk, Norway: Norwegian Forest Research Institute. [Number of pages unknown].

YEAR 1982

ABST A general description of the energy situation, the role of forest energy, and the energy supply from small trees is given in Chapter 1, along with a description of forestry in Norway. Stands needing thinning are described in Chapter 2. The systems used to thin these stands are described in Chapter 3. Thinning patterns, technique, and equipment for felling, bucking, and conversion are described and the productivity for some of the methods for felling and bunching are indicated. In Chapter 4, current research and development for felling and bunching of small trees is described. The following subjects are mentioned: bunching with long boom cranes on processors, thinning systems for tree-sections, and bunching with small skidders. An outline of methods, equipment, and machinery that require research and development, small machines for conversion in the stand, bunch conversion, a mechanized cleaning in early thinning stands, and methods and equipment for difficult terrain conditions are described. Plans for future research and development are described and given priority.

KEYW Bunching, felling, machinery, processor, skidder, systems

299 AUTH Kubasak, E.

TITL Problem of thinning technique in the socialist states of Europe.

PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 89-90.

YEAR 1969

ABST Fifth-row thinning in young stands is discussed. Mechanization is increasing and much attention is given to extraction.

KEYW Felling, processing, row thinning, shortwood, systems, volumes

300 AUTH Kuhlman, E.G.; Hodges, C.S., Jr.; Froelich, R.C.

TITL Minimizing losses to Fomes annosus in the Southern United States.

PUBL Res. Pap. SE-151. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 16 p.

YEAR 1976

ABST Recommended practices to control annosus root rot in southern pine plantations are summarized. Among them are wide spacings, reduced thinnings, and the application of borax to stump surfaces immediately after harvesting. The disease can be easily and economically controlled in the Southern United States if recommended practices are followed.

KEYW Chemicals, damage, plantation, South

301 AUTH Kushlyayeu, V.F.

TITL Study of fellingless method of tree cutting.

PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting: 1969 September; Stockholm, Sweden: Royal College of Forestry: 245-246.
YEAR 1969
ABST A Dyatel-machine is being developed by the Soviet Union for complete mechanization of tree cutting.
KEYW Felling, machinery

302 AUTH Lane, R.A.
TITL An evaluation of operational harvesting techniques and systems applicable to the commercial thinning of southern pine plantations.
PUBL Blacksburg, VA: Virginia Polytechnic Institute and State University,School of Forestry and Wildlife Resources, Industrial Forestry Operations. 139 p. M.S. thesis.
YEAR 1981
ABST An annotated bibliography was compiled that identified procedures for thinning in numerous geographical locations from the simulation of two harvesting systems, then production and cost trends were developed. Production was found to be influenced by the thinning pattern, system, and stand characteristics.
KEYW Plantation, systems, thinning

303 AUTH Lanford, B.L.
TITL Application of a small forwarder in plantation thinning.
PUBL Southern Journal of Applied Forestry. 6(4): 183-188.
YEAR 1982
ABST A description is given of a timed study of two forwarder models in three locations. Travel speed, loading, and cost implications also are discussed.
KEYW Damage, economics, equations, forwarder, loading, machinery, plantation, South, systems

304 AUTH Lanford, B.L.
TITL Performance of the TJ30 in row thinning.
PUBL In: Proceedings of harvesting small timber: waste not, want not; 1981 April 28-30; Syracuse, NY. Madison, WI: Forest Products Research Society: 63-71.
YEAR 1982
ABST In Alabama, during the summer of 1980, thinning studies were conducted which included Timberjack model TJ30 and model RW30 feller-bunchers cutting in a row pattern. Factors such as tree size, load size, stand density, and brush were examined for influence over production rates. Only d.b.h. and trees per acre significantly affected the productive time to fell and bunch trees. The TJ30 and its predecessor, the RW30, were found to have similar production rates. Row cutting was the only method used. Selection from both sides and selection from one side were also compared.
KEYW Equations, feller-buncher, machinery, row thinning, selective thinning

305 AUTH Lanford, B.L.
TITL Productivity and costs of the Timberjack 30 feller-buncher.
PUBL Forest Products Journal. 33(1): 62-66.

YEAR 1983
ABST Time and production studies were conducted on the Timberjack 30 feller-buncher during row thinning in a pine plantation and natural stands. Factors such as tree size, load size, stand density, and brush were examined for influence on production rates. Only d.b.h. and trees per acre significantly affected the productive time to fell and bunch trees. Cutting methods--row only, selection from both sides, and selection from one side--were compared. Cutting only the row was more productive than either of the side selection methods, but the increase did not make multiple passes more productive than a single pass where both row and selective trees were cut. In one test stand, felling and bunching costs averaged $10.43 per cunit. A qualitative evaluation of the Timberjack 30 was also included.
KEYW Economics, feller-buncher, machinery, methods, row thinning

306 AUTH Lanford, B.L.; Hoffman, R.E.; Iff, R.H.
TITL A small skidder for thinning: the Holder A55 F tractor.
PUBL Southern Journal of Applied Forestry. 7(3): 161-165.
YEAR 1983
ABST The growing need for small equipment to thin young plantations prompted a study of a small skidder--the Holder A55 F. Time and production data were collected in a thinning application of the skidder equipped with a Farmi JL-30 cable winch. Cost averaged $15.63 per cunit for a 200-foot skid. The replacement of the winch with a small hydraulic grapple, such as the power tire grapple, was simulated. Costs per unit volume were decreased by adding the grapple ($11.13 per cunit for a 200-foot skid).
KEYW Damage, economics, machinery, skidder

307 AUTH Lanford, B.L.; Sirois, D.L.
TITL Drive-to-tree rubber-tired feller-buncher production studies.
PUBL Gen. Tech. Rep. SO-45. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 14 p.
YEAR 1983
ABST The increasing use of machines to fell trees has created a need for better understanding of this process and what factors affect production. This report provides information on feller-buncher activities and presents means for estimating production rates for rubber-tired drive-to-tree machines. Four types of machines were tested and were found to have different production rates. Total productive felling and bunching time per tree increased with increasing d.b.h. and distance between trees, and decreased with larger accumulations. During the test, the average production per productive machine-hour ranged from 109 to 214 trees per hour.
KEYW Feller-buncher, harvesting, time study

308 AUTH Lanford, B.L.; Stokes, B.J.
TITL Biologically based thinning systems: state-of-the-art.
PUBL IN: Proceedings of the Technical Association of the Pulp and Paper Industry; Research and Development Division conference; 1982; Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 281-286.
YEAR 1982

ABST Thinning pine plantations is a major problem facing forest landowners in the South. Thinning alternatives, including different thinning patterns as well as different equipment and systems, were investigated in this study. Row and selective approaches were evaluated and found to be comparable in unit cost. Selective patterns left larger residual trees than row patterns. As tree size decreased, marginal unit cost increased rapidly with all alternatives.
KEYW Cable system, economics, feller-buncher, machinery, plantation, row thinning, selective thinning, silviculture, skidder, systems

309 AUTH Lanford, B.L.; Stokes, B.J.
TITL Performance of Timbco Hydro-buncher on steep terrain.
PUBL In: Proceedings of the 1984 Mountain logging symposium; 1984 June 5-7; Morgantown, WV: West Virginia University Press: 282-291.
YEAR 1984
ABST In evaluating the Timbco Hydro-buncher, field tests were made in west-central Alabama both on level slopes and on steep slopes of loblolly pine. Production estimates are developed for the machine to operate up, down, and across slopes and on level ground, and recommendations are given.
KEYW Feller-buncher, loblolly, machinery, steep slopes

310 AUTH Lanford, B.L.; Stokes, B.J.
TITL Techniques for silvicultural thinning.
PUBL In: Proceedings of thinning southern pine plantations workshop; 1984 October 30-November 1; Long Beach, MS. Washington, DC: Forest Industries Training and Education Council, American Pulpwood Association: 65-70.
YEAR 1985
ABST The various methods of thinning southern pine plantations are described, and production and cost of each method are given.
KEYW Economics, machinery, selective thinning, systems

311 AUTH Lanson, N.I.
TITL Thinning increases growth of 60-year-old cherry maple stands in West Virginia.
PUBL Res. Pap. NE-571. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeast Forest Experiment Station. 8 p.
YEAR 1985
ABST Previously unmanaged cherry maple stands were thinned to 60-percent relative stand density. Thinning reduced stand mortality, distributed growth onto fewer, larger stems, and increased individual tree growth. Periodic basal area growth of individual trees was greater in thinned stands than in control stands. Relative stand density in the thinned stands increased 1.6 percent annually.
KEYW Harvester, marking, natural stand, selective thinning

312 AUTH Lapointe, G.B.
TITL Precommercial thinning in the Atlantic provinces.
PUBL In: Proceedings of harvesting the South's small trees; 1983 April 18-20; Biloxi, MS. Madison, WI: Forest Products Research Society: 49-57.
YEAR 1984

ABST Precommercial thinning in dense, young stands is carried out for an estimated 6,000 to 8,000 hours annually in Atlantic Canada, and this figure could double in the next few years. The work is performed manually with brush saws. Man-day productivity typically averages 0.33 hectare and costs about $330 per hour. Interest in mechanization is high but as yet no trends are evident. After mechanization, the resulting increase in merchantable volume growth and reduction in rotation age will assist in offsetting a predicted wood shortage, provided appropriate forest protection policies are in place.
KEYW Labor, precommercial thinning, spacing

313 AUTH Leary, R.A.; Stephans, R.F.
TITL Direction fields for stand management decision-making.
PUBL Journal of Forestry. 85(2): 16-17.
YEAR 1987
ABST This article discusses the development of direction fields and their use in projecting future yields.
KEYW Growth and yield, volumes

314 AUTH Ledoux, C.B.
TITL Cable yarding residue after thinning young stands: a break-even simulation.
PUBL Forest Products Journal. 34(9): 5-40.
YEAR 1984
ABST A break-even analysis and a simulation model allow logging contractors to develop residue removal guidelines using various yarding equipment. Break-even contours are illustrated showing three zones and the minimum piece size that the operator could harvest to break even in each zone.
KEYW Biomass, cable system, economics, equipment, models

315 AUTH Ledoux, C.B.; Brodie, J.D.
TITL Maximizing financial yields by integrating logging and silvicultural techniques.
PUBL Journal of Forestry. 80(11): 717-720.
YEAR 1982
ABST Substantial gains in yields of merchantable volume and profits from Douglas-fir stands in mountainous terrain can be achieved by considering logging and silvicultural techniques simultaneously. To maximize financial yield, managers must consider not only the length of the rotation, timing of entries, and volume removal per entry but also the proper harvesting equipment, precommercial and commercial thinning treatments, and fertilizer applications. The joint returns from combinations of techniques are greater than the sum of returns from each technique applied independently.
KEYW Cable system, economics, fertilization, machinery, models, precommercial thinning, silviculture, steep slopes, West

316 AUTH Ledoux, C.B.; Starnes, L.W.
TITL Cable logging production rate equations for thinning young-growth Douglas-fir.
PUBL Forest Products Journal. 36(5): 21-24.

YEAR 1986
ABST A cable-logging thinning simulation model and field study data from cable-thinning production studies have been assembled and converted into a set of simple equations. These equations can be used to estimate the hourly production rates of various cable-thinning machines operating in mountainous terrain. The equations include seven cable yarders and are applicable to uphill thinnings of Douglas-fir from low to high volume removals. The equations can be used to develop reasonable approximations of delay-free hourly production for several cable yarders operating in thinnings under a variety of site and stand conditions.
KEYW Cable system, models, site, West

317 AUTH Lee, Y.J.; Barclay, H.J.
TITL Ten-year growth response of a 25-year-old and a 55-year-old Douglas-fir stand to thinning and urea fertilization.
PUBL Info. Rep. BC-X-260. Vancouver, Canada: Pacific Forest Research Center. 14 p.
YEAR 1985
ABST Ten years after, thinning had almost doubled growth in diameter but affected growth in net volume only; gross volume was only minimally affected. Fertilization in the 25-year-old stand significantly increased growth in mean d.b.h. in the 2nd and 3rd year and significantly increased volume growth in the first 3 years with diminishing effect thereafter. Growth responded most to combined thinning and fertilizer treatment. Thinning significantly decreased mortality, on which fertilizer had negligible effect.
KEYW Fertilization, growth and yield, volumes

318 AUTH Lemin, R.C., Jr.; Burkhart, H.E.
TITL Predicting mortality after thinning in old-field loblolly pine plantations.
PUBL Southern Journal of Applied Forestry. 7(1): 20-23.
YEAR 1983
ABST Four equations were compared for predicting mortality after thinning in old-field loblolly pine plantations. Survival curves for thinned, old-field loblolly pine plantations in coastal plain and piedmont Virginia are given.
KEYW Growth and yield, loblolly, models, plantation, South

319 AUTH Lenhart, D.J.; Clutter, J.L.
TITL Cubic foot yield tables for old-field loblolly pine plantations in the Georgia piedmont.
PUBL Series 3, Rep. 22. Macon, GA: Georgia Forest Research Council. 12 p.
YEAR 1971
ABST During the period 1948 through 1967, nearly 2.5 million acres of pine plantations were established in the State of Georgia. This establishment effort has, for the most part, been concentrated on old-field sites and has primarily involved slash pine and loblolly pine. Detailed information on the yield and stand structure of slash pine plantations has been published. Similar information for planted stands of loblolly pine is given.
KEYW Equations, growth and yield, loblolly, plantation, South

320 AUTH Lennane, I.
TITL Thinning steep country using plastic chutes.
PUBL LIRA Tech. Rel. 2(1). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1980
ABST High-density, polyethylene chutes (Alkathene) were tested. A disadvantage was the difficulty of shifting chute lines through slash. Advantages were minimal bark damage to residual trees and few dominant trees felled. The method appears to be flexible; cost competitive with cable thinning, requiring low capital investment; and to have silvicultural advantages.
KEYW Machinery, steep slopes, systems

321 AUTH Levesque, R.
TITL Short-term evaluation of the Timbco 2518 feller-buncher in eastern Canada.
PUBL Tech. Note TN-72. Vancouver, B.C., Canada: Forest Engineering Research Institute of Canada. 27 p.
YEAR 1983
ABST The note describes the Timbco 2518 feller-buncher and gives specifications. Short-term productivity based on time studies is given as well as some data on longer-term performance. The ergonomics of the machine and some of its uses are discussed in the note.
KEYW Feller-buncher, machinery, steep slopes

322 AUTH Liechty, H.O.; Mroz, G.D.; Reed, D.D.
TITL The growth and yield responses of a high site quality red pine plantation to seven thinning treatments and two thinning intervals.
PUBL Canadian Journal of Forest Research. 16(3): 513-520.
YEAR 1986
ABST Ten years after seven thinning treatments had been carried out, diameter growth responses to thinning were similar to those reported on poor and medium red pine sites. Periodic basal area increment was maximized at a lower and much broader range of residual densities than on lower quality sites.
KEYW Growth and yield, red pine, site

323 AUTH Little, S.; Mohr, J.J.
TITL Five-year effects from row thinning in loblolly pine plantations in eastern Maryland.
PUBL Res. Pap. NE-12. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 15 p.
YEAR 1963
ABST In 1954, four thinning treatments were investigated in a 17-year-old loblolly plantation. Five-year data indicated that diameter increment after thinning was related to original diameter, crown class, crown ratio, and degree of release. Thinning every other row produced greatest growth stimulation but, in spots, left an insufficient number of desirable crop trees. Fourth- and fifth-row thinning produced little stimulation. Third-row thinning was not recommended.

KEYW Growth and yield, loblolly, Northeast, plantation, row thinning

324 AUTH Little, S.; Somes, H.A.
TITL Results 18 years after planting loblolly pines at different spacings.
PUBL Forest Res. Note NE-80. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 3 p.
YEAR 1958
ABST In 1939, a test of four spacings in a planting of loblolly pine seedlings was begun in an abandoned field on Maryland's eastern shore. The spacings were 4, 5.7, 8, and 11.3 feet between trees; each spacing was replicated on four 100-foot-square plots. In the 4- and 8-foot spacings, rows and trees within rows were 4 or 8 feet apart, with trees opposite in adjoining rows. In the other two spacings, trees in adjoining rows were staggered. Trees 8 feet apart staggered in rows 4 feet apart gave the 5.7-foot spacing; trees 16 feet apart in rows 8 feet apart gave the 11.3-foot spacing.
KEYW Growth and yield, loblolly, spacing

325 AUTH Lloyd, F.T.; Jones, E.P., Jr.
TITL A thinning rule for slash pine plantations on a medium site.
PUBL In: Barnett, James P., ed. Proceedings of the first biennial southern silvicultural research conference; 1980 November 6-7; Atlanta, GA. Gen. Tech. Rep. SO-34. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 131-136.
YEAR 1981
ABST The aim was to determine, after thinning, residual densities that produce near maximum periodic growth for medium plantation sites with an average height of 63 feet at age 25. Net 5-year growth (in pounds of dry wood per acre) was fitted to the corresponding values of Stahelin's percent stocking obtained from unthinned stands covering a wide range of densities. This approach is based on the assumption that the growth of the thinned stand will quickly recover to that of an unthinned stand of the same percentage stocking. The stand ages at which thinnings should be made were also established. This age is defined as the point where the annual accretion of expected yield from a first thinning begins to decrease.
KEYW Growth and yield, methods, plantation, slash pine, South

326 AUTH Lohrey, R.E.
TITL Growth of longleaf pine plantations after initial thinning.
PUBL Res. Note SO-175. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 5 p.
YEAR 1974
ABST Periodic annual volume growth after the first thinning (at age 25) increased with residual density, exceeding two cords per acre with a basal area of above 70 square feet. Diameter and volume growth of individual trees was related to stand density and initial d.b.h.
KEYW Growth and yield, longleaf, plantation, South

327 AUTH Lohrey, R.E.
TITL Growth responses of loblolly pine to precommercial thinning.

PUBL Southern Journal of Applied Forestry. 1(3): 19-22.
YEAR 1977
ABST Results up to age 16 are reported for a study comparing four precommercial thinning intensities and two thinning methods (strip and/or selective) in a loblolly pine stand. Mean d.b.h. and merchantable volume were inversely related to stand density. The optimal density for maximum merchantable pulpwood volume was 750 trees per acre; this was the lowest density in the trial. Strip thinning is preferred to selective thinning on economic grounds, at least to a residual density of 1,450 stems per acre.
KEYW Diseases, economics, growth and yield, loblolly, precommercial thinning, selective thinning, South, strip thinning

328 AUTH Lohrey, R.E.
TITL Precommercial thinning increases diameter and height growth of slash pine.
PUBL Res. Note SO-152. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 4 p.
YEAR 1973
ABST Precommercial thinnings in a 3-year-old slash pine stand with about 5,000 stems per acre increased diameter growth of trees in all crown classes and increased height growth of dominants and codominants. For maximal growth, residual densities of 750 trees per acre or less were needed. At residual stocking levels of 1,400 and 2,800 trees per acre, strip and selective thinnings were equally effective.
KEYW Equations, growth and yield, precommercial thinning, selective thinning, slash pine, South, strip thinning

329 AUTH Lohrey, R.E.
TITL Precommercial thinning of direct-seeded loblolly pines.
PUBL Res. Note SO-139. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 4 p.
YEAR 1972
ABST In 1961, nine thinning treatments were applied to 0.1-acre plots of loblolly pine 3 years old. The treatments were four intensities of selective thinning: three strip thinnings to simulate machine thinning; a combination of strip and selective thinning; and an unthinned control. At 1 year, mean d.b.h. was inversely related to stand density and directly related to the mean height of dominant and predominant trees. Response to thinning was most pronounced at 1,500 trees per acre.
KEYW Loblolly, precommercial thinning, selective thinning, South, strip thinning

330 AUTH Lohrey, R.E.
TITL Precommercial thinning of direct-seeded slash pine.
PUBL Progress Rep. Summary FS-SO-1102-3.8. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 1 p.
YEAR 1978
ABST The purpose of this study was to determine the response of slash pine to several methods and intensities of precommercial thinning. The 12

treatments being tested included an unthinned check, 5 intensities of selective thinning, 4 strip or row thinnings, and 2 combinations of strip plus selective thinning. All treatments were applied at stand age 3 and were replicated three times in a completely randomized design.

KEYW Methods, plantation, precommercial thinning, row thinning, selective thinning, slash pine, South, strip thinning

331 AUTH Lohrey, R.E.; Bailey, R.L.

TITL Yield tables and stand structure for unthinned longleaf pine plantations in Louisiana and Texas.

PUBL Res. Pap. SO-133. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 53 p.

YEAR 1976

ABST Detailed tables of trees per acre, basal area, and cubic-foot yields in eight volume categories by 1-inch diameter classes are presented for several combinations of site index, age from planting, and trees per acre at age 15.

KEYW Growth and yield, longleaf, plantation, South

332 AUTH Lynch, D.W.

TITL Mechanical thinning of young conifer stands.

PUBL ASAE Pap. 71-174. St. Joseph, MI: American Society of Agricultural Engineers. 10 p.

YEAR 1971

ABST Thinning dense stands using hand tools or power saws was all but physically impossible. Furthermore, economic justification for such a costly precommercial treatment was questionable. Consequently, foresters generally have left these stands untreated. The product loss of timber and pulp has been significant. Mechanical thinning measures have been used but problems still exist.

KEYW Machinery, precommercial thinning, West

333 AUTH Lysons, H.H.

TITL Harvesting thinnings on steep ground.

PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].

YEAR 1977

ABST A critical need exists for a system suitable for harvesting small commercial thinnings on steep slopes to meet management plans for intensive forestry. An analysis of the cost structure of small log harvesting is reviewed relative to the operational requirements for commercial thinning. A new yarding system, currently under development, is presented as a promising approach to solving major problems of harvesting small logs.

KEYW Economics, juvenile wood, selective thinning, steep slopes

334 AUTH MacArthur, J.D.

TITL Logging methods for small forests.

PUBL Info. Rep. FMR-X-63. Ottawa, Ontario, Canada: Forest Management Institute, Canadian Forestry Service, Department of the Environment. 27 p.
YEAR 1974
ABST This review of logging methods for small forests in eastern Canada and the United States has been made from an analysis of the available literature and from discussions of ownership with people in both research and operations in this field. Recommendations are made that the problem of mechanization of such logging operations should receive considerably more attention by government and industry.
KEYW Chipping, damage, forecasts, forwarder, machinery, methods, processing, skidder

335 AUTH MacDonald, M.A.; Soule, H.M.
TITL Evaluation of rotary cutting devices for thinning of regeneration stands.
PUBL ASAE Pap. 85-1600. St. Joseph, MI: American Society of Agricultural Engineers. 33 p.
YEAR 1985
ABST Six commercial and prototype rotary cutting mechanisms were evaluated statistically and qualitatively for potential use in feller/chipper harvesters. Empirical data were collected on the relationship between cutting torque and specimen diameter for a fixed tooth blade, two circular saw blades, and three rotary flails.
KEYW Chipping

336 AUTH MacKintosh, J.; Bunn, E.H.
TITL Current research into radiata pine thinning operations in New Zealand.
PUBL New Zealand Journal of Forestry Science. 6(2): 228-240.
YEAR 1976
ABST Economic evaluation of alternative silvicultural regimes for radiata pine has shown that a substantial opportunity cost can be incurred if the growth of the crop trees is penalized, and their date of harvest deferred, in the interests of obtaining a sale for thinnings. The effect is greatest when a pruned final crop element that has been defined from an early age is allowed to be severely checked through competition from unpruned neighbors. In this instance, the case for production thinning depends largely on whether the unwanted trees can be extracted before they markedly impinge on the growth of the final crop trees. Such competition is apparent from an early age in selectively pruned stands, to the extent that production thinning becomes difficult to justify. However, the onset of competition may be delayed by distinguishing the crop component of the stand from the thinnings component from the outset, by separating the two elements as much as possible, by applying treatments to the crop that will give it a distinct competitive advantage, and by arranging the thinnings in ways that favor mechanization and cheap extraction of small diameter material. Trials have been established to test the concept, and more are planned.
KEYW Economics, machinery, plantation, silviculture, skidder, strip thinning, systems

337 AUTH Maki, T.E.
TITL Developing pine plantations in relation to harvesting systems.
PUBL APA Tech. Pap. 67. Washington, DC: American Pulpwood Association. 5 p.
YEAR 1968
ABST Harvesting system trends and the amount of regeneration necessary to meet future demands with respect to length of rotation are outlined for an uncertain future. Spacing, limb diameter and knot size, stand structure, and thinning are also covered.
KEYW Machinery, plantation, silviculture, spacing

338 AUTH Maki, T.E.
TITL Major considerations in thinning southern pines.
PUBL In: Thinning and mechanization: Proceedings of IUFRO Meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 63-68.
YEAR 1969
ABST Several major considerations in thinning of pines in the Southern United States have been discussed principally in the context of manmade forests. It has been emphasized that currently there is no unanimity among foresters and land managers concerning either the feasibility or even the need for thinning. Nevertheless, it appears fairly certain that in the intensive forestry being practiced in the southern pine region today, thinnings can be used to maximize the production of usable wood. Major considerations in thinning include choice of method, spacing, species, timing, and assessment of site quality in relation to stand establishment. In the future, advances in tree improvement will also have an important bearing on stand management and may well point toward increasing rotation lengths, thus further accentuating the importance of thinnings as a cultural measure in forest production.
KEYW Methods, plantation, row thinning, selective thinning, site, South, spacing

339 AUTH Mallonee, E.H., Jr.
TITL Effects of thinning and seasonal time of nitrogen fertilization on the growth of pole-sized loblolly pine.
PUBL Dissertation Abstracts International. Ann Arbor, MI: Xerox University Microfilms. 205, 36(8): 3698-3699.
YEAR 1976
ABST Thinning was combined with different dates of fertilizing to give a total of six treatments, applied to a 17-year-old loblolly pine plantation of medium site quality in North Carolina. Responses were assessed over 2 years by measuring annual dry wood yield per hectare; foliar nitrogen and phosphorus; needle length and weight; stem form; and diameter growth, percentage earlywood and latewood, and wood density for breast height and upper stems. A modified ge-xrd x-ray diffraction apparatus was used to study intraring and interring wood density. A beam of x rays was passed through a thin wood sample into a scintillation counter; variations in wood density were recorded directly on a strip chart recorder.
KEYW Fertilization, growth and yield, loblolly, plantation

340 AUTH Mann, W.F., Jr.
TITL Early yields of slash pine planted on a cutover site at various spacings.
PUBL Res. Pap. SO-69. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 16 p.
YEAR 1971
ABST Tabulation of basal areas, cordwood and cubic-foot volumes, average d.b.h., and diameter distributions for 14-year-old slash pine planted in central Louisiana is given, with regression equations developed to predict these parameters.
KEYW Equations, growth and yield, plantation, slash pine, South, spacing

341 AUTH Mann, W.F., Jr.
TITL Response of loblolly pine to thinning.
PUBL Journal of Forestry. 50(6): 443-446.
YEAR 1952
ABST How and when should loblolly pine be thinned? It is suggested that thinning practices best suited to sawlog production are not necessarily the most profitable where pulpwood is the main objective.
KEYW Growth and yield, pulpwood, silviculture, South

342 AUTH Mann, W.F., Jr.; Dell, T.R.
TITL Yields of a 17-year-old loblolly pine stand planted on a cutover site at various spacings.
PUBL Res. Pap. SO-70. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 9 p.
YEAR 1971
ABST Tabulation of cubic-foot volumes, diameters, and basal areas for loblolly pines planted in southwest Louisiana on a cutover area representing a wide range of site indices is given, with regression equations for predicting these parameters.
KEYW Equations, growth and yield, loblolly, plantation, South, spacing

343 AUTH Mann, W.F., Jr.; Enghardt, H.G.
TITL Growth of planted slash pine under several thinning regimes.
PUBL Res. Pap. SO-76. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 10 p.
YEAR 1972
ABST Three intensities of thinning, each started at 10, 13, and 16 years, were applied to slash pine planted on a highly productive, cutover site in central Louisiana. Over a 9-year period, early and heavy thinnings increased diameter growth but reduced volume growth. The longer initial thinnings were deferred, the slower was the response in diameter growth. Growth on unthinned plots was good.
KEYW Growth and yield, methods, plantation, slash pine, South

344 AUTH Mann, W.F., Jr.; Feduccia, D.P.
TITL Tree sizes harvested in different thinnings--another look.
PUBL Res. Pap. SO-131. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 6 p.
YEAR 1976

ABST In loblolly planted at 10- by 10-feet spacing, plots given light or medium thinning had slightly more sawtimber-sized trees and board-foot volume than unthinned and heavily thinned plots at all ages. Average diameters of all trees were largest on control plots, followed by lightly thinned plots. Trends were similar for 32-year-old slash pine planted at 6- by 7-foot intervals.
KEYW Growth and yield, loblolly, methods, plantation, slash pine, South

345 AUTH Mann, W.F., Jr.; Lohrey, R.E.
TITL Precommercial thinning of southern pines.
PUBL Journal of Forestry. 72(9): 557-560.
YEAR 1974
ABST After reviewing 25 years of research on precommercial thinning, the authors conclude that all southern pine stands with 5,000 or more stems per acre should be thinned. To minimize costs and prevent reduction in live crowns, stands should be strip thinned at about age 3. A residual stocking of 500 to 750 stems per acre will give rapid diameter growth without reducing volume production.
KEYW Growth and yield, methods, precommercial thinning, selective thinning, South, strip thinning, wildlife

346 AUTH Manthy, R.S.; Lemmien, W.A.; Rudolph, V.J.; James, L.M.
TITL A time study of two logging techniques for thinning red pine plantations.
PUBL Pap. 49(3). East Lansing, MI: Agricultural Experiment Station, Michigan State University. 16 p.
YEAR 1967
ABST Time study data are used to compare the labor costs of two stem selection logging methods commonly used to harvest pulpwood in the second and third thinnings of a red pine plantation. Logging methods compared are: (1) a conventional 2-man boltwood operation, and (2) a 2-man tree-length logging operation. Labor costs for the boltwood method were found to be significantly lower than for the tree-length method. Using the boltwood method, a cord of pulpwood was harvested and stacked at roadside for a labor cost of $10.26 (5-inch trees) to $6.57 (9-inch trees). Labor costs for the tree-length method were $10.98 (5-inch trees) to $7.65 (9-inch trees).
KEYW Longwood, plantation, systems

347 AUTH Markstrom, D.C.; Troxell, H.E.; Bolat, C.E.
TITL Wood properties of immature ponderosa pine after thinning.
PUBL Forest Products Journal. 33(4): 33-36.
YEAR 1983
ABST Trees from growing stock levels of 20, 60, and 100 in sapling and pole stands were sampled at three vertical positions--0, 25, and 50 percent of total height above the 1-foot stump. Wood grown during the 10-year period after initial thinning was compared for growth and wood properties. Wide differences in radial growth, produced by thinning treatments, were not accompanied by significant differences in specific gravity, latewood percentage, tracheid length, nor microfibril angle. However, all properties except microfibril angle were significantly affected by vertical position on the stem.
KEYW Growth and yield

348 AUTH Martin, J.W.
TITL Implementing a plantation thinning harvesting system.
PUBL In: Proceedings of harvesting the South's small trees; 1983 April 18-20; Biloxi, MS. Madison, WI: Forest Products Research Society: 103-108.
YEAR 1984
ABST The requirement to deliver wood from plantation thinning with a 5-foot 3-inch stick length or clean chip specification is an economic obstacle to mechanized thinning operations. The impact of thinning in a 5-foot 3-inch wood system greatly increases the cost of handling the already numerous small trees. At American Can, an intensive study was conducted to determine the best method of accomplishing plantation thinning under the mill and yard constraints imposed. The system implemented, based on study results, consisted of a six-man crew equipped with a Case Uni-loader feller-buncher, Iron Mule 4500F prehauler, haul truck with two bundle bucker trailers and two chain saws for delimbing. The operation was geared to cutting meandering corridors spaced about 60 feet apart with selective thinning in between in accordance with a marked leave-tree approach. The crew cut 10-foot stick lengths for the forwarder. The 10-foot wood was slashed into 5-foot 6-inch segments with a bundle bucker slasher before mill delivery. Moving 10-foot wood in the woods proved very cost-effective compared to moving 5-foot 3-inch wood direct from the stump.
KEYW Plantation, South, systems

349 AUTH Mason, R.R.
TITL Behavior of Ips populations after summer thinning in a loblolly pine plantation.
PUBL Forest Science. 15(4): 390-398.
YEAR 1969
ABST The effects of summer thinning on the population behavior of Ips avulsus (Eichh.) and Ips grandicollis (Eichh.) were investigated in a loblolly pine plantation in Tennessee. Thinning attracted large numbers of both Ips species, which infested slash in the experimental area. Beetles that invaded the thinning did not attack living trees; they only colonized fresh slash. Window-trap collections of flying beetles were significantly correlated with the intensity of attacks on slash. The flight of I. avulsus into each new thinning was briefer and more intense than the flight of I. grandicollis. Daytime temperatures and light also strongly influenced the flight intensity of I. avulsus. Newly emerged beetles, instead of accumulating in the old thinning, dispersed to new sources of attraction. Dispersal of I. avulsus was much more rapid than that of I. grandicollis. It is concluded that in pulpwood stands in the Midsouth, Ips species are rarely a hazard to healthy living trees because of summer thinning.
KEYW Diseases, loblolly, plantation, South

350 AUTH Matney, T.G.; Sullivan, A.D.
TITL Compatible stand and stock tables for thinned and unthinned loblolly pine stands.
PUBL Forest Science. 28(1): 161-171.

YEAR 1982
ABST Procedures are presented for estimating diameter distributions in thinned and unthinned old-field plantation loblolly pine stands. Compatible equations for projecting per acre (hectare) values of number of trees, basal area, and total tree cubic foot (meter) volume from initial stand condition are first developed. Three Weibull distribution representations of diameter distributions are then calculated, so that when integrated for per acre (hectare) basal area and cubic foot (meter) volume, the result is the same as predicted or observed. A Fortran computer program utilizing the procedures developed is available from the authors on request.
KEYW Growth and yield, loblolly, management, South

351 AUTH McClay, T.A.
TITL Loblolly pine growth as affected by removal of understory hardwoods and shrubs.
PUBL [Series number unknown]. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. [Number of pages unknown].
YEAR 1955
ABST An opportunity arose to determine the early reaction of a pine overstory to several understory treatments developed from a hardwood control study initiated in 1946. One of three treatments in this study resulted in the elimination or annual removal of the understory in a pine stand. The treatments were: (1) annual summer burning, (2) annual winter burning, and (3) annual summer foliage spray with chemicals following an initial burn. Each treatment, as well as a control treatment where nothing was done to the understory, consisted of three replicated 1/4-acre plots as part of a randomized block design.
KEYW Chemicals, growth and yield, hardwood, loblolly

352 AUTH McClurkin, D.G.
TITL Soil moisture trends following thinning in shortleaf pine.
PUBL In: Proceedings of Soil Science Society. Madison, WI: Soil Science Society: 135-138.
YEAR 1961
ABST In 19-year-old shortleaf pine plantations in northern Mississippi, thinning markedly increased available soil moisture in the middle and latter part of the growing season. In the second year after thinning, the moisture increase was associated with more rapid and more prolonged diameter growth. Regardless of the amount of moisture available, diameter growth rates decreased during periods of rapid depletion of soil moisture.
KEYW Growth and yield, plantation, shortleaf, site, South

353 AUTH McConchie, B.D.; Groome, J.G.
TITL Factors which influence companies in forest management decisions.
PUBL New Zealand Journal of Forestry Science. 6(2): 292-298.
YEAR 1976
ABST Factors that generally influence companies in making forest management decisions include company strategy, policy and objectives, anticipated wood demand-supply situation, financial considerations, and government

ABST incentives. Decisions regarding production thinnings will also be affected by the cost and value of the thinnings, the long-term forest management strategy particularly with respect to stand parameters and the wood properties and quality of thinnings. Responses to these factors largely depend on the nature of the companies growing forests. Three types are recognized, based upon the relationship between annual sales and the value of the fixed assets. Most sawmilling companies are in the first group where annual sales are greater than the value of the fixed assets. Pulp and paper companies exemplify the second group, whose annual sales have comparable fixed assets and value. The final group, with annual sales less than the value of the fixed assets, includes purely forest-growing companies with no processing interests.

KEYW Economics, silviculture

354 AUTH McCracken, F.I.
TITL Decay following thinning of sweetgum sprout clumps: 26-year results.
PUBL Southern Journal of Applied Forestry. 9(1): 26-28.
YEAR 1985
ABST Butt rot in living sweetgum stems was observed 15 and 26 years after the companion living stems were cut in a 55-year-old stand of sprout origin. It was concluded that decay risk associated with thinning sprout clumps can apparently be eliminated by undercutting and taking care to prevent splitting during felling.
KEYW Damage, diseases

355 AUTH McCulley, R.D.
TITL Thinning in conifers of the Western United States.
PUBL In: Thinning and mechanization: Proceedings of IUFRO Meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 49-57.
YEAR 1969
ABST Discussion of amount of thinning in ponderosa pine, lodgepole pine and Douglas-fir and thinning specifications, practices, and problems.
KEYW Damage, diseases, methods, precommercial thinning, West

356 AUTH McCulley, R.D.
TITL Thinning practice for conifers in the Lake States and the Northeast in the United States.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 58-62.
YEAR 1969
ABST Eastern white, red, and jack pine species are discussed. No statistics are given on amount of thinning done. The author records that spacing is 6 feet by 6 feet; market and economic considerations have little or no influence on density of planting; some stands are thinned precommercially.
KEYW Economics, methods, Northeast, plantation, red pine, silviculture, spacing

357 AUTH McKee, B.
TITL All aged? Even aged?
PUBL Alabama's Treasured Forests. 4(1): 9-11.

YEAR 1985
ABST Comparison of yield and financial returns which explains the workings of all-aged and even-aged management options.
KEYW Economics, silviculture, systems

358 AUTH McKee, B.
TITL Site, stocking and expected yields of loblolly and slash pine plantations.
PUBL Circ. ANR-398. Auburn, AL: Alabama Cooperative Extension Service, Auburn University. 8 p.
YEAR 1984
ABST The amount of wood that can be grown on a given area of land depends on many factors: species, age, number and size of trees, length of rotation, and quality of land are all important. The production of wood can be affected by changing or adjusting some of these factors. Planting improved seedlings, rather than common nursery stock, generally increases wood yield. Periodic thinnings can control the number and size of trees to assure acceptable growth rates.
KEYW Loblolly, plantation, pulpwood, site, slash pine, volumes

359 AUTH McNab, W.H.
TITL An overcrowded loblolly pine stand thinned with fire.
PUBL Southern Journal of Applied Forestry. 1(1): 24-26.
YEAR 1977
ABST A low-intensity backfire in an 18-year-old pine stand in central Georgia reduced the number of stems by 65 percent. The relationship between bark thickness and tree survival by diameter class showed that the results of the fire were silviculturally desirable; no tree larger than 4 inches at the groundline or with bark over 0.7 inch thick died after the fire. It is suggested that low-intensity fires should be considered as a precommercial thinning technique but only for stands with a wide range of diameters.
KEYW Damage, loblolly, precommercial thinning, silviculture, South

360 AUTH McTague, J.P.; Bailey, R.L.
TITL Compatible basal area and diameter distribution models for thinned loblolly pine plantations in Santa Catarina, Brazil.
PUBL Forest Science. 33(1): 43-51.
YEAR 1987
ABST A simultaneous prediction is developed for basal area growth and yield based on diameter percentiles. It is suggested that the diameter distribution percentiles essentially provide a description of stand history. A noniterative technique is demonstrated for recovering the Wiebull distribution parameters and generating a diameter distribution consistent with basal area.
KEYW Equations, growth and yield, loblolly, silviculture

361 AUTH Megille, X.De
TITL Report on mechanized thinning in the French forests.

PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry. [Number of pages unknown].
YEAR 1969
ABST A large part of the harvest in French forests has traditionally come from selective cuts in older stands or thinnings in young stands; the latter type receives increased attention today. On flat land, tree-length systems have been used so far. The introduction of the articulated tractor has favored this system. In mountainous regions, several types of cable systems have been developed for thinnings, those of the multiple-cable type being the most popular today.
KEYW Machinery

362 AUTH Meyers, R.K.
TITL Firewood yields from thinning an immature piedmont oak stand.
PUBL Forestry Bull. 40. Clemson, SC: Clemson University, Department of Forestry. 5 p.
YEAR 1984
ABST A 15-acre, 40-year-old upland oak stand in the Clemson experimental forest was thinned to leave 60 to 80 crop trees per acre. Six to nine cords per acre of high quality wood was removed in thinning.
KEYW Hardwood, selective thinning

363 AUTH Miles, J.A.; Tilt, S.M.; Hartsough, B.R.
TITL Modeling an improved logging carriage for downhill thinning.
PUBL ASAE Pap. 85-1601. St. Joseph, MI: American Society of Agricultural Engineers. 21 p.
YEAR 1985
ABST A computer model was developed to analyze the three-dimensional motion of alternative skyline yarder carriages. The model predicted that a clamping carriage would cause less damage during breakout and lateral yarding, but increase tension in the haulback line between the carriage and the tailhold.
KEYW Cable system, damage

364 AUTH Minin, N.S.; Moskaleva, S.A.
TITL Effect of thinning on the physical and mechanical properties of wood in Scots pine plantations.
PUBL Lesnoi Zhurnal. 2: 68-71.
YEAR 1986
ABST Investigations were made of wood properties from 42-year-old plantations that had been thinned out at various intensities, 12 and 30 years previously. Data are presented on wood density, compression, and static bending strength. Results show that wood density did not decrease when 15-25 percent of the standing volume was removed.
KEYW Plantation, selective thinning

365 AUTH Minko, G.
TITL Cost of thinning regeneration in second-rotation radiata pine plantations with a motorized brushcutter and with a hand slasher.
PUBL Australian Forest Research. 15: 515-520.

YEAR 1985
ABST A brushcutter and a hand slasher were evaluated for thinning 1- to 6-year-old regeneration of radiata pine. The productivity of both implements was negatively and significantly related to the base diameter of measured trees and the number of stems per acre.
KEYW Precommercial thinning, Monterey pine

366 AUTH Mitchell, R.G.; Waring, R.H.; Pitman, G.B.
TITL Thinning lodgepole pine increases tree vigor and resistance to mountain pine beetle.
PUBL Forest Science. 29(1): 204-211.
YEAR 1983
ABST Thinned and unthinned stands of lodgepole pine in eastern Oregon were evaluated in 1980 to determine their vigor and susceptibility to attack by outbreak populations of the mountain pine beetle. Application of a vigor rating system, based on amount of stem growth per square meter of crown leaf area, showed that thinnings from below improved vigor of residual stand and reduced beetle attack. Beetle mortality was significant in unthinned and lightly thinned stands where current annual growth of stemwood of residual trees averaged less than 80 grams per square meter of foliage. Stands with mean vigor ratings of about 100 were beginning to suffer beetle attack. There was no mortality in heavily thinned stands where vigor ratings exceeded 120. These findings suggest that lodgepole pine can be managed through stocking control to obtain fast-growing, large-diameter trees and to avoid attack by the mountain pine beetle.
KEYW Diseases, West

367 AUTH Moehring, D.M.; Ralston, C.W.
TITL Diameter growth of loblolly pine related to available soil moisture and rate of soil moisture loss.
PUBL In: Proceedings of Soil Science Society of America. 31: 560-562.
YEAR 1967
ABST In six sawtimber stands in northeastern Louisiana, loblolly pine diameter growth was related to the amount and weekly rate of change of available soil moisture from June through August. Regardless of the amount of moisture available during the summer, growth was curtailed when loss of soil moisture was rapid. Consequently, the soil moisture content at which tree growth ceased was highly variable.
KEYW Equations, growth and yield, loblolly, site, South

368 AUTH Moini, S.; Miles, J.A.
TITL Analysis of shaking techniques for harvesting conifer cones.
PUBL In: Proceedings of Symposium on engineering systems for forest regeneration; 1981 March 2-6; Raleigh, NC. St. Joseph, MI: American Society of Agricultural Engineers: 334-343.
YEAR 1981
ABST This study quantifies various parameters affecting the vibrational behavior of conifer trees. The initial experiments determined the linear and torsional forces required for cone detachment from limbs. The effects of various factors such as amplitude, direction, duration, and number of applications were investigated.
KEYW Chipping, loblolly, machinery, plantation, pruning, skidder

369 AUTH Morey, J.
TITL Conservation and economical harvesting of wood fiber by using the whole tree.
PUBL Tappi. 58(5): 94-97.
YEAR 1975
ABST Ninety pulp mills now use whole-tree chips, and statistics prove the feasibility of such use. Whole-tree utilization provides two significant improvements: twice as high a fiber yield is realized because previously unmerchantable stands are harvested; and raw material costs are drastically lowered. Whole chips can be delivered to the mill at $6.22 per ton, compared to $20 to $30 per ton with conventional harvesting. Half the acreage is required, fewer laborers are needed, and the land is immediately ready for replanting. Equipment needed includes a feller-buncher with a shear, grapple skidders, and a whole-tree chipper. The latter chips material up to 22 inches in diameter, takes whole trees with limbs and tops intact, and is completely portable. A six-man crew using this equipment can produce 280 tons of chips per day in one shift. The operation is very effective in pine thinning, in selective cutting of hardwoods, and in cleaning up after logging operations.
KEYW Chipping, economics, feller-buncher, machinery, pulpwood, skidder, systems, whole-tree

370 AUTH Morley, P.M.
TITL Optimizing the wood resource study of integrated logging operations in eastern Canada.
PUBL Forest Products Journal. 28(10): 73-76.
YEAR 1978
ABST Determination of change from single product to multiproduct operations. Four systems of slashing and sorting are discussed and wood flow for each is illustrated. Logging terminology is defined and factors affecting processing outlined.
KEYW Multiproduct, systems

371 AUTH Muntz, H.H.
TITL Ice damage to pine plantations.
PUBL Southern Lumberman. 175(2201): 142-145.
YEAR 1947
ABST Description of damage from leaning and breakage caused by ice storms in 1944 and 1947 to slash pine that was planted out of natural range and to longleaf, loblolly, and shortleaf pines. Species susceptibility is considered.
KEYW Damage, loblolly, longleaf, plantation, shortleaf, slash pine

372 AUTH Naslund, B.
TITL Optimal rotation and thinning.
PUBL Forest Science. 15(4): 446-451.
YEAR 1969

ABST Discussion of the problem of simultaneous determination of optimal rotation and thinning. First, the classical conditions for optimal rotation are derived using continuous discounting. These derivations assume that the current net receipts (positive or negative) for the growing forest are given. At the same time that the optimal rotation is derived, a managerial decision on the optimal time for the first thinning is allowed for and the interdependence of the two decisions is discussed. Finally, the management of the forest is treated as a continuous process when the problem is to determine at each point the optimal activity, such as the amount of thinning, together with the determination of optimal rotation. Restrictions may be imposed, such as by limited manpower, or by the fact that the amount of thinning cannot be negative or larger than the available amount of timber. As a result, the problems must be solved subject to side conditions that are often functions of the decision variable. The possibility of using the solution as a device for decentralized decisionmaking in a forest enterprise is discussed.
KEYW Economics, silviculture

373 AUTH Neilson, D.A.
TITL A preliminary study of the production potential of the Iglend-Jones mini-alp in second growth Douglas-fir.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST Results of a recent study indicate that a four-man crew thinning second growth Douglas-fir (Pseudotsuga menziesii) can produce 1,550 to 1,850 cubic feet (44 to 52 centimeters) per day on slopes of 10 to 50 percent, average skyline distances of 150 to 300 feet (46 to 91 meters), and average lateral distances of 30 to 50 feet (9 to 15 meters). The use of intermediate supports can extend both yarding distances and deck capacity.
KEYW Cable system, selective thinning, West

374 AUTH Nelson, T.C.
TITL Early competition in slash pine plantations.
PUBL Res. Note 10. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Experiment Station. 2 p.
YEAR 1952
ABST Although it is well known that early growth of planted southern pine is affected by initial spacing, there is not much information to show when competition begins or how great an effect it exerts upon growth. Results of a study in slash pine indicated that mutual competition in 6-by 6-foot plantations begins as early as third year after planting. Diameter growth of individual trees is reduced, but growth in height after 7 years in the field is not affected.
KEYW Growth and yield, plantation, slash pine, South, spacing

375 AUTH Nelson, T.C.
TITL Influence of thinning on risks in the southern pinery.

PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 163-168.
YEAR 1969
ABST Thinning affects risk from diseases, insects, glaze, and wind.
KEYW Damage, diseases, methods, selective thinning, site

376 AUTH Nelson, T.C.
TITL Thinning systems and yield.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 110-117.
YEAR 1969
ABST Light, frequent thinning beginning at an early age appears best for maximizing both quantity and quality of growth and yield of loblolly, slash, longleaf, shortleaf, and Virginia pines.
KEYW Forecasts, growth and yield, loblolly, longleaf, methods, row thinning, selective thinning, shortleaf, slash pine, South

377 AUTH Nelson, T.C.; Lotti, T.; Brender, E.V.; Trousdell, K.B.
TITL Merchantable cubic-foot volume growth in natural loblolly pine stands.
PUBL SO-127. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Experiment Station. 12 p.
YEAR 1961
ABST A series of 153 plots were selected in 20- to 60-year-old stands of natural loblolly pine with a wide range in site index and density, in Georgia, South Carolina, and Virginia. Approximately one-third of the plots were thinned at the time of plot establishment to a range of residual densities. These plots were rethinned and another one-third received their first thinning at the end of the first 5-year growth period. The authors discuss results of analyses of the 5- to 10-year cubic-foot volume growth.
KEYW Growth and yield, loblolly, natural stand, South

378 AUTH Newnham, R.M.
TITL A Fortran program to simulate pulpwood harvesting machines.
PUBL Info. Rep. FMR-X-7. Ottawa, Ontario, Canada: Canadian Forestry Service, Department of Fisheries and Forestry, Forest Management Institute. 32 p.
YEAR 1967
ABST Using the simulation model, it is possible to obtain estimates of harvesting time for machines of different size and operating characteristics working in a wide range of stand conditions. A description of how the Fortran computer program may be used to perform any desired test is given.
KEYW Machinery, models, pulpwood

379 AUTH Newnham, R.M.
TITL Productivity of harvesting machines designed for thinning estimation by simulation.
PUBL Infor. Rep. FMR-X-25. Ottawa, Ontario, Canada: Canadian Forestry Service, Department of Fisheries and Forestry, Forest Management Institute. 25 p.
YEAR 1970

ABST Using a model developed to simulate mechanized thinning (Newnham and Sjunnesson, 1969), the parameters describing the B 105 feller-processor and its method of operation have been tested over a range of values in order to estimate the potential productivity of the machine and to suggest areas in which its design could be improved. The most important factors affecting pine are machinery, systems felling and extraction, boom in/out speed and boom slewing speed. Recommendations are made for improvements to the harvesting machine to decrease the felling-cycle time, which with the basic machine was 90 percent of the total time, and thus significantly reduced the harvesting time.
KEYW Economics, feller-buncher, felling, models, processor, row thinning, strip thinning

380 AUTH Newnham, R.M.; Sjunnesson, S.
TITL A Fortran program to simulate harvesting machines for mechanized thinning.
PUBL Info. Rep. FMR-X-23. Ottawa, Ontario, Canada: Canadian Forestry Service, Department of Fisheries and Forestry, Forest Management Institute. 6 p.
YEAR 1969
ABST A computer program is described written in Fortran IV that simulates the passage of a harvesting machine through a forest stand that is being thinned. It is used to study the effects of machine size, configuration, and operating speeds on productivity. The basic machine has a felling shear mounted at the end of a boom and a processing unit for delimbing and bucking. The model may be used to simulate feller-processors, feller-bunchers, or strip-road processors of different designs. The type of stand data required for the model is described, and examples of the input and output of the program are given.
KEYW Feller-buncher, machinery, models, processor

381 AUTH Nicolls, M.
TITL Bunching to increase skidder productivity.
PUBL Tech. Rel. 3(1). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1981
ABST Discussion of trial conditions, existing logging methods, results, comments, cost, and conclusions.
KEYW Bunching, economics, machinery, skidder, systems

382 AUTH Nilsson, P.O.
TITL Logging techniques in thinning today and tomorrow in Sweden.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 91-92.
YEAR 1969
ABST The author discusses first-time thinning using short-wood and Rep.s on three mechanized systems.
KEYW Damage, forecasts, shortwood, systems, volumes

383 AUTH Nilsson, P.O.; Hyppel, A.
TITL Studies on decay in scars of Norway spruce.

PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 141-143.
YEAR 1969
ABST An investigation was conducted on the spread of fungi in trees after they had been scarred.
KEYW Damage, diseases, machinery

384 AUTH Okuma, M.
TITL Manufacturing of plywood from small diameter logs.
PUBL [Place of publication unknown]: Council for Scientific and Industrial Research. 14 p.
YEAR 1985
ABST A laminated veneer board was developed as a substitute for plywood in Japan. Laminated veneer board is manufactured from small pieces of veneer from Japanese-grown softwood thinnings. Laminated veneer board panels are suitable for floor sheathing.
KEYW Labor, machinery, processing

385 AUTH Ollerenshaw, S.
TITL The role of thinning in the management of privately owned plantations.
PUBL New Zealand Journal of Forestry Science. 6(2): 283-291.
YEAR 1976
ABST The role of thinning is considered from the time of the decision to commence investing capital in plantations. Thinnings provide raw material for use by a firm's log-conversion plants and contribute to the cash flow. They reduce the cost of growing wood in the plantation by reducing the debt on the plantation and by reducing the time taken to grow trees of a desired diameter. Capital is returned in the form of reinvestment and a larger annual increment earned on a smaller invested capital. Thinning gives a flexibility to the products cut from, and overall wood resource represented by, the plantation. Silvicultural roles express themselves in the well-being of the total enterprise. The effect upon the condition and size of the knots is the most important of these roles. Thinning reduces the likelihood of attack by pathogens. For decisionmaking in the future, we need a tool that correlates the effect of thinnings on a plantation with the effect on the industrial wood-converting side of the enterprise.
KEYW Diseases, economics, forecasts, plantation, silviculture

386 AUTH Omberg, H.
TITL The formation of tracks made by forwarders on forest soil.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 144-150.
YEAR 1969
ABST Summary of experiments performed in Sweden to throw light on track formation. Technical and biological studies including measurement techniques are discussed.
KEYW Damage, forwarder, machinery, site

387 AUTH Omule, S.A.Y.
TITL Response of coastal Douglas-fir to precommercial thinning on a medium site in British Columbia.

PUBL Res. Note 100. Victoria, BC, Canada: Ministry of Forests. 56 p.
YEAR 1985
ABST Thinning regimes were studied ranging from no thinning to frequent, heavy thinning. All thinning regimes increased growth of residual trees trees and produced trees of greater merchantable volume than no thinning
KEYW Growth and yield, volumes

388 AUTH Omule, S.A.Y.
TITL Results from a correlated curve trend experiment on spacing and thinning of coastal Douglas-fir.
PUBL Res. Note 93. Victoria, BC, Canada: Ministry of Forests. 22 p.
YEAR 1984
ABST Analysis showed that diameter, height, and growth increased with a decrease in density. Mortality, basal area, total volume, and basal area growth decreased as density decreased. Stand merchantable volume was not affected by density except at extremes.
KEYW Growth and yield, volume

389 AUTH Opie, J.E.
TITL Predictability of individual tree growth using various definitions of competing basal area.
PUBL Forest Science. 14(3): 314-322.
YEAR 1968
ABST Methods are reviewed for evaluating the competition experienced by individual trees in terms of surrounding basal area. The properties of an ideal method are outlined. A new model, zone count, is presented, together with an approximation allowing quick field work. The various methods, each for a wide range of plot sizes or basal area factors, are then compared as follows: each definition (method by size) is used in turn in a regression predicting basal area increment for individual trees of an even-aged stand of eucalyptus, the residual mean square providing criterion.
KEYW Forecasts, growth and yield, models

390 AUTH Outslay, G.
TITL Methods and equipment development for thinning young forest.
PUBL In: Proceedings of advances in reforestation: Western Reforestation Coordinating Committee; 1968 December 3; San Francisco, CA. Portland, OR: Western Forestry and Conservation Association: 32-34
YEAR 1968
ABST Discussion of new machinery and principles to use so that thinning small trees in Western United States can be economical.
KEYW Economics, machinery, West

391 AUTH Pearson, R.G.; Weir, R.J.; Smith, W.D.
TITL Utilization of pine thinnings.
PUBL In: Thinning southern pine plantations: Proceedings of southern forest economic workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 124-151.
YEAR 1980
ABST Report on the quantity and quality of wood. Stem size, fusiform wood, compression wood, and juvenile wood characteristics are discussed. Tests of wood are also discussed for properties such as static bending,

compression parallel to grain, and toughness on clear wood loblolly. Types of utilization are summarized taking into consideration thinning for fuel board materials, structural applications, and changes in the future for diameter trees.

KEYW Forecasts, juvenile wood, loblolly, pulpwood, South

392 AUTH Pease, D.A.
TITL Stand treatment, thinning have major role in Finnish forestry.
PUBL Forest Industries. 108(1): 26-27.
YEAR 1981
ABST Discussion of thinning damage and the operation of the Makeri 33T.
KEYW Damage, precommercial thinning, processor

393 AUTH Perkins, R.H.; Lynn, K.D.
TITL Procedure for estimating bunching and swinging distances in roading operations.
PUBL Forest Products Journal. 29(3): 19-23.
YEAR 1979
ABST This computerized method that incorporates irregularitis of terrain was developed for estimation of average skidding distance. The method is applicable to a two-step bunching and skid system and direct stump-to-landing. It is based on a 3-D space system procedure for calculation and is written in Ratfor and Fortran IV language.
KEYW Bunching, economics, models, roads, skidder

394 AUTH Persson, P.
TITL The influence of various thinning methods on the risk of windfalls, snowbreaks, and insect attacks.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 169-174.
YEAR 1969
ABST An account of experiments in Sweden where damage surveys have been made. Damage by windfalls, snowbreaks, and icing are discussed and a brief section is included on insects.
KEYW Damage, diseases, methods, site

395 AUTH Petrov, A.P.; Tikhonov, A.S.; Smirnova, A.I.
TITL Evaluating the effectiveness of thinning.
PUBL Lesnoe Khozyaistvo. 12: 26-28.
YEAR 1984
ABST Details are given on the economics of thinning middle-aged Scots pine in Latvia. Three thinning techniques are compared. All trees were felled a chain saw. The three different methods of skidding used are compared.
KEYW Bunching, felling, methods, selective thinning

396 AUTH Phillips, D.R.; Sheffield, R.M.
TITL The small timber resource in the southeast.
PUBL In: Proceedings of Harvesting the South's small trees; 1983 April 18-20; Biloxi, MS. Madison, WI: Forest Products Research Society: 7-17.
YEAR 1984

ABST The five Southeastern States from Virginia to Florida contain 87.4 million acres of commercial forest land. Approximately 56 percent of these acres support primarily small timber (seedling-saplings or poletimber). On a volume basis, small timber accounts for 31 percent of softwood growing stock and 37 percent of hardwood growing stock. Where total-tree biomass is concerned, small timber represents 40 percent of above ground total tree weight for softwoods and 50 percent for hardwoods. Small timber trees occur in many forest conditions. Where they represent young growing stock for the future, they should not be cut, but where they are inhibiting, or are incidental to, more valuable trees they should be removed. It is not always economical to remove small stems either in a partial cut or sawtimber cut, but when evaluating small trees, one should consider not only their biomass yield, but the detrimental effect they can have on the residual stand if they are left standing.

KEYW South, volumes

397 AUTH Pienaar, L.V.

TITL Analyzing alternative management strategies for unthinned plantations.

PUBL Southern Journal of Applied Forestry. 2: 26-32.

YEAR 1977

ABST When a tract of land is used to produce timber by planting and clearcutting plantations of a single species, the expected financial return depends on the choice of species, planting density, and harvest age as well as establishment and interest costs. An analytical procedure will aid these decisions rather than provide an explicit optimal solution is demonstrated for old-field slash pine plantations in the coastal region of Georgia.

KEYW Economics, Forecasts, models, plantation, silviculture, slash pine, south

398 AUTH Pienaar, L.V.

TITL An approximation of basal area growth after thinning based on growth in in unthinned plantations.

PUBL Forest Science. 25(2): 223-232.

YEAR 1979

ABST Any evaluation of plantation management regimes that include one or more thinnings required information on the response of growth and yield to thinning. A procedure is proposed by which the predicted basal area growth and yield in thinned plantations is derived from unthinned plantations of the same age, site index, and number of stems per hectare as remain in the thinned plantation immediately after thinning. An estimate of growth after thinning is obtained by adjusting the predicted growth of the unthinned plantation to allow for the degree of suppression that existed in the thinned plantation, relative to the unthinned counterpart. Different thinning intensities and thinning methods can be accommodated within the proposed general formulation, so that it can be used to evaluate the potential role of thinning in plantation management

KEYW Growth and yield, planation, row thinning, selective thinning, slash pine plantation

399 AUTH Pienaar, L.V.; Bailey, R.L.; Clutter, M.L.

TITL Pine plantation thinning practices.

PUBL Georgia Forest Res. Pap. 51. Athens, GA: Univeristy of Georgia, School of Forest Resources. 5 p.

YEAR 1984

ABST A survey was made of 39 thinning operations in loblolly and slash pine. Age at thinning was 13 to 27 years with an average age of 22. Plantations were thinned by row or by a combination of row and selectively. Plantation and thinning operation data are shown by thinning method and by number of previous thinnings; production rates, costs, and revenues are shown by thinning operation (shortwood, treelength, or whole-tree chipping). and by species. Shortwood operators caused considerably less damage to site and residual trees.

KEYW Row thinning, selective thinning, site, whole-tree

400 AUTH Pienaar, L.V.; Shiver, B.D.; Grider, G.E.

TITL Predicting basal area growth in thinned slash pine plantations.

PUBL Forest Science. 31(3): 731-741.

YEAR 1985

ABST A single projection model for both thinned and unthinned plots, based on basal area and age at the start of the projection period, was found to be inappropriate. The precision of the basal area projections was significantly improved when a measure of thinning intensity was included in the model. Results contradict the common assumption that basal area growth in thinned stands will be the same as in unthinned stands.

KEYW Growth and yield, models, plantation, slash pine

401 AUTH Pierrot, V.C.

TITL Thinning--manual or mechanical.

PUBL In: Proceedings of harvesting the South's small trees; 1983 April 18-20; Bilozi, MS. Madison, WI: Forest Proucts Research Society: 38-45.

YEAR 1984

ABST The author investigates the relative advantages of mechanical and manual thinning methods, evaluating the various mechanical systems in economic and silvicultural terms.

KEYW Economics, silviculture, systems

402 AUTH Powell, L.H.

TITL Evaluation of logging-machine protoypes: Drott feller-buncher.

PUBL Woodlands Rep. No. WR/29. Pointe Claire, Quebec, Canada: Pulp and Paper Research Institute of Canada. 10 p.

YEAR 1970

ABST The Drott feller-buncher was studied in June 1970. Detailed timing during the harvesting of 58 premeasured plots provided the specific insformation on tree and stand factors expected to affect the productivity of the feller-buncher. The average harvesting time per tree was 41 cmin. The most important factor affecting harvesting times was volume per tree. The harvesting time increased by 1 cmin for an increase in volume per tree of 2 cubic feet. Average volume per tree was 7.3 cubic feet. Average volume per bunch was 78 cubic feet. The results showed also that the volume per bunch could be increased from 54 to 96 cubic feet without any significant effect upon harvesting time per tree. Average productivity as calculated from the average time per tree was 10.5 cunits per productive machine-hour.

KEYW Feller-buncher, machinery

403 AUTH Powell, L.H.
TITL Evaluation of new logging machines: Timberjack RW-30 timber tree-length harvester.
PUBL Logging Research Rep. LRR/60. Pointe Claire, Quebec, Canada: Pulp and Paper Research Institute of Canada. 20 p.
YEAR 1974
ABST The machine, originally designed in Australia for thinning pine plantations and now manufactured and marketed by Eaton Yale Ltd., Woodstock, Ontario, Canada, was tested in Abies balsamea/Picea mariana forest in Quebec in June 1974. The average volume per tree during the study was 0.08 cubic meter (2.9 cubic feet). The average harvesting time per tree was 0.85 minute, and the average output, calculated from average time and average volume per tree, was 5.8 cubic meters (2.05 cunits) per productive machine hour. The most important factors influencing harvesting time were differences between operators, volume per tree, and slope in the direction of travel. The harvester produced bunches of tree lengths, which were neatly arranged for movement to roadside piles by a grapple skidder. Average bunch volume was 0.93 cubic meters (33 cubic feet), with an average of 11 trees per bunch.
KEYW Bunching, damage, economics, machinery, plantation

404 AUTH Powers, D.W.; Skelly, J.M.
TITL Growth loss due to Fomes annosus (Heterobasidion annosum) in loblolly pine as associated with increasing levels of disease incidence and severity.
PUBL In: Proceedings of the American Phytopathological Society; 1975 March 19-21; Blacksburg, VA: Virginia Polytechnic Institute and State University. [Number of pages unknown].
YEAR 1976
ABST In thinned stands of loblolly pine sampled on three high-hazard and three low-hazard sites, the lowest incidence of Heterobasidion annosum was 72 percent on a high-hazard and 52 percent on a low-hazard site. Total increment since thinning 10 and 15 years prior to harvest was measured. Some negative correlations between total increment and the length of infected primary or secondary roots were significant on the high-hazard but not on the low-hazard sites. Another comparison indicated a reduction in annual increment as severity increased on a high-hazard site.
KEYW Diseases, growth and yield, loblolly

405 AUTH Prebble, R.L.
TITL Chain strops in skidder thinning.
PUBL Rep. 7(7). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1982
ABST Trials were set up to assess the viability of chain strops in skidder thinning. The results of these trials in production situations are summarized.
KEYW Economics, radiata pine, row thinning, selective thinning, skidder, systems

406 AUTH Price, C.
TITL The distribution of increment and the economic theory of thinning.
PUBL Quarterly Journal of Forestry. 79(3): 159-168.
YEAR 1985
ABST Examination of the effectiveness of thinning in concentrating volume increment onto the more valuable stems suggests that only early, low thinning is advantageous. In terms of discounted revenue, a heavy crown thinning is justified. It is concluded that distribution of volume increment is not a very important criterion for decisionmaking.
KEYW Economics, precommercial thinning

407 AUTH Putkisto, K.
TITL Research on the mechanization of harvesting thinning timber in Finland.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 247-248.
YEAR 1969
ABST Discussion of problems with rising labor cost, and need for mechanization and research.
KEYW Economics, labor, machinery

408 AUTH Putnam, N.E.; Kellog, L.D.; Olsen, E.D.
TITL Production rates and costs of whole-tree, tree-length, and log-length skyline thinning.
PUBL Forest Products Journal. 34(6): 65-69.
YEAR 1984
ABST Production rates and costs were determined for harvesting smallwood by different methods of skyline yarding: whole-tree (yarding with limbs and tops), tree-length (bucking done on the landing), and log-length (limbing, topping, and bucking done on the slope). A rubber-tired skidder was used to swing and sort the variously cut trees from the landing to a site on the haul road for further processing. The production rates for the felling and yarding cycles of each logging method were predicted from regression equations. Felling production rates were 3.60 cubic meters per hour for log-length, 4.70 cubic meters per hour for tree-length, and 6.17 cubic meters per hour for whole-tree. Yarding production rates were 5.52 cubic meters per hour for log-length and 5.83 cubic meters per hour for both tree-length and whole-tree. Cost analysis indicated that, where feasible, cold decking (stacking in front of the yarder) of log-length material is the most cost-effective method because it eliminates the need for a skidder to swing the logs. However, where cold decking is not feasible and a skidder is used, the whole-tree method is the next least expensive: cost per unit is 12 percent less than log-length yarding.
KEYW Economics, juvenile wood, longwood, selective thinning, shortwood, skidder

409 AUTH Ramanauskas, R.P.
TITL New machines for tending fellings.
PUBL Lesnoe Khozyaistvo. 8: 36-39.
YEAR 1984
ABST A description is given of the universal telescopic grapple developed in Lithuania for mechanization of thinning operations. The machine can help in many forestry operations such as felling, loading, stacking, and off-loading. It will also handle materials such as chips, gravel, logging debris, slash, etc. It can also be used in planting stock grown

in large containers on felled areas where the stumps have not been removed.
KEYW Biomass, equipment, felling, loading

410 AUTH Randall, R.M.; Darr, D.R.
TITL Douglas-fir thinning values sensitive to price-diameter relationships.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST The impact of four alternative price-diameter relationships on the present net worths obtained from an evaluation of commercial and precommercial thinning is examined in Douglas-fir stands varying in age and site class. Of special interest are how different relationships affect the magnitudes of projected returns and how rankings are affected. Alternative assumptions can produce large differences in present net worth values in some cases, changing the financial desirability of thinning stands of Douglas-fir. Analysis shows that large differences persist over a wide range of interest rates.
KEYW Economics, precommercial thinning, site

411 AUTH Raymond, O.H.
TITL The introduction of the RW30 Windsor tree harvester into early pine thinnings.
PUBL Appita. 29(6): 453-456.
YEAR [Year unknown]
ABST The development of the Windsor tree harvester is outlined and production and availability statistics are given. Mechanical problems and, where possible, their solutions are discussed, as well as nonmechanical problems associated with the introduction of any mechanized harvesting system. A series of theoretical cost is also given.
KEYW Economics, harvester, machinery

412 AUTH Raymond, O.H.
TITL Mechanical tree selection in thinning.
PUBL Tech. Rel. 5(7). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1983
ABST The mechanical tree selection method used in Australia is described.
KEYW Row thinning, selective thinning

413 AUTH Raymond, O.H.
TITL Unmarked pine thinnings--a commercial option.
PUBL Australian Forestry. 48(3): 193-198.
YEAR 1985
ABST Methods of systematic thinning are described that are being applied to pulpwood production of radiata pine on relatively poor soils. The first method takes every fifth row and a staggered pattern of every fourth tree in the other rows. Second thinnings are being done where they first take every third row, and a prescribed pattern is shown. For mechanized thinnings, every fifth row is cut and also groups of three trees adjacent to the fifth row, alternately to right and to left. Subsequent selection thinnings are semisystematic, taking one in three of the remaining trees.
KEYW Pulpwood, radiata pine, row thinning, selective thinning

414 AUTH Reich, R.; Dippon, D.
TITL Stand level optimization via a dynamic simulation model for slash pine plantations.
PUBL In: New forests for a changing world: Proceedings of the 1983 convention of the Society of American Foresters; 1983 October 16-20; Portland, OR. Bethesda, MD: Society of American Foresters. [Number of pages unknown].
YEAR 1983
ABST A break-even economic model incorporating the opportunity cost of capital as a guide for thinning existing stands of eastern white pine was created for interactive use on microcomputers by field foresters. Basal area stocking for each time period was set at the highest level capable of earning the alternate stocking levels exceeded the discount rate. For the extremes of stand and market parameters examined, young stands (40 years) could be thinned once or twice depending on discount rate. Older stands (80 years) should be final harvested immediately. The economic basal areas determined in the model can be used to modify individual tree-marking guidelines.
KEYW Diseases, models, plantation, South

415 AUTH Reisinger, T.W.
TITL The impact of future markets, management regimes, and mechanized harvesting systems on commercial thinning investments in plantations of loblolly pine.
PUBL Blacksburg, VA: Virginia Polytechnic Institute and State University, School of Forestry and Wildlife Resources. 146 p.
YEAR 1983
ABST The controversy regarding commercial thinning continues to intensify as pine plantation acreage in the South increases. The controversy has caused industrial and nonindustrial landowners to reexamine the economic returns from their plantation investments. The present study was undertaken to develop investment guidelines for the management of loblolly pine plantations. Computer simulation was used to evaluate the effect three management regimes and three mechanized thinning systems can have on current thinning investments when the economic returns from thinning are compared with a no-thin management regime. Simulation results indicate that long-term investment advantages favor thinning only slightly, regardless of the future price/market scenario assumed. This slight difference suggests that such factors as wood flow, tax advantages, and future product requirements of manufacturing facilities are primary in determining profits from commercial thinning. Generally, shortrun cost and production differences between thinning systems are more significant than the long-term investment effects. Consequently, the type of mechanized thinning system employed has a negligible impact on the total investment.
KEYW Economics, silviculture, systems

416 AUTH Reisinger, T.W.
TITL A simulation approach to evaluating mechanized thinning systems in pine plantations.
PUBL ASAE Pap. 84-1613. St Joseph, MI: American Society of Agricultural Engineers. 17 p.
YEAR 1984
ABST Computer simulation techniques were used to evaluate mechanized thinning systems on intensively managed pine plantations. Four simulation programs were linked to predict tree growth and stand development and to model intermediate thinnings and final harvests. Results of a row-select thinning with a mechanized shortwood system are presented to illustrate this approach.

KEYW Growth and yield, models, plantation, row thinning, selective thinning, systems

417 AUTH Reisinger, T.W.
TITL A simulation-based approach to evaluating commercial thinning decisions in loblolly pine plantations.
PUBL Southern Journal of Applied Forestry. 9(4): 211-216.
YEAR 1985
ABST Four computer simulation programs (Ptaedar, Ptaeda, Genmac, and Hss) were linked to predict tree growth per stand development and to model mechanized thinning and final harvest. Simulated results were then combined with an investment analysis program to calculate the net present worth of a wide range of strategies (spacing, rotation ages, etc.). An example analysis is given.
KEYW Growth and yield, models

418 AUTH Reisinger, T.W.; Stuart, W.B.; Walbridge, T.A.
TITL Simulation of the input of future market prices on the management of loblolly pine plantations.
PUBL Forest Products Journal. 35(3): 26-30.
YEAR 1985
ABST Four simulation programs were combined to predict tree growth and stand development and model intermediate thinnings and final harvest for an economic analysis of management alternatives for an average loblolly pine plantation. This data may be helpful in determining the correct time for commercial thinning.
KEYW Economics, growth and yield, loblolly, models, South, systems

419 AUTH Rennolls, K.; Peace, A.
TITL Flow models of mortality and yield for unthinned forest stands.
PUBL Forestry. 59(1): 47-58.
YEAR 1986
ABST Previous work on the modeling of forest mortality caused by self-thinning is reviewed and discussed.
KEYW Models

420 AUTH Reukema, D.L.
TITL The Wind River Douglas-fir spacing trial.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST Discussion of the effects of spacing on number of trees, height, basal area, and cubic volume.
KEYW Plantation, spacing

421 AUTH Riitters, K.; Brodie, J. D.
TITL Implementing optimal thinning strategies.
PUBL Forest Science. 30(1): 82-85.
YEAR 1984
ABST Optimal thinning regimes for achieving several management objectives were derived from two stand-growth simulators by dynamic programming. Residual mean tree volumes were then plotted against stand density on density management diagrams. The results support the use of density management diagrams for comparing, checking, and implementing the results of optimization analyses.
KEYW Growth and yield, models, silviculture, West

422 AUTH Riitters, K.; Brodie, J.D.; Kao, C.
TITL Volume versus value maximization illustrated for Douglas-fir with thinning.
PUBL Journal of Forestry. 80(2): 86-89,107.
YEAR 1982
ABST Economic and physical criteria for selecting rotation length in even-aged stands are reviewed with examples of their optimization. To demonstrate the tradeoff between physical volume, economic return, and stand diameter, examples of thinning regimes for maximizing volume, forest rent, and soil expectation are compared with an example of maximizing volume without thinning. The soil expectation criterion consistently accounts for the market premium and logging and other silvicultural costs.
KEYW Economics, growth and yield, volumes, West

423 AUTH Ritter, H.
TITL Whole-tree harvesting of Norway spruce smallwood with the aid of a small portable winch.
PUBL Allgemeine Forstzeitschrift. 5: 88-90.
YEAR 1985
ABST Guidelines are given for the use of the Miller portable winch for log extraction during first thinnings in spruce stands. Performance and cost data are presented based on 2 years experience in West Germany.
KEYW Cable system, whole-tree

424 AUTH Rockell, A.L.
TITL The influence of silviculture and the role of thinning on a region's wood supply.
PUBL New Zealand Journal of Forestry Science. 6(2): 253-258.
YEAR 1976
ABST The Bay of Plenty region in the central North Island is well endowed with plantations of radiata pine, which are grossly uneven in age-class distribution. The older stands are needed until 1990 to sustain supplies until the much younger stands can take over. Instability in the older stands and susceptibility of other pines to disease has induced a high level of cutting now and a critical supply situation about 1990 even after rotations have been shortened to the point where utilization of thinnings is no longer viable. Relatively short rotations are proposed for radiata pine for post-1990 wood supply from state forests. These rotations are primarily to produce sawlogs, some of high quality resulting from intensive silviculture, the rest of lesser quality from minimal silviculture. The end result will be sawlogs from the butts producing about 40 percent of the yield with the untended tops destined for chips and pulpwood.
KEYW Diseases, plantation, silviculture

425 AUTH Rogers, W.A., Jr.
TITL The effect on productivity of the TH-100 harvester.
PUBL Baton Rouge, LA: Louisiana State University, School of Forestry and Wildlife Management. 60 p. M.S. thesis.
YEAR 1971

ABST This study was designed to develop tables for predicting the harvesting time and the efficiency of the TH-100 thinner-harvester in slash pine plantations. Time studies were made on 5 machines harvesting 668 trees. The harvesting cycle was divided into six steps measured separately. The times for each step of the harvesting cycle were subjected to an analysis of variance, and an analysis of regression where this was indicated. The results of these analyses were combined into prediction equations, which were used to produce tables of harvesting times by diameter and height of the trees to be cut. Two types of tables are presented. The first is a table of predicted harvesting times by tree size (diameter and height), and the second is a table of predicted times to harvest one cubic foot of solid wood by tree size. The study indicates that increasing tree size causes the harvest time to increase. This increase in time is proportionately less than the associated increase in volume so that the machine efficiency also increases with tree size.

KEYW Harvester, machinery, plantation, pulpwood, row thinning, slash pine, South, systems

426 AUTH Roise, J.P.

TITL An approach for optimizing residual diameter class distributions when thinning even-aged stands.

PUBL Forest Science. 32(4): 871-881.

YEAR 1986

ABST The determination of optimal residual diameter class distributions along with optimal timing of thinning and harvest is formulated as an unconstrained nonlinear program, and the results are discussed.

KEYW Economics

427 AUTH Roper, G.D.

TITL Heavy thinning of forest trees.

PUBL Quarterly Journal of Forestry. 118(2): 173-175.

YEAR 1974

ABST A guideline for thinning.

KEYW Growth and yield, plantation

428 AUTH Ross, E.W.

TITL Fomes annosus in the Southeastern United States: relation of environmental and biotic factors to stump colonization and losses in the residual stand.

PUBL Tech. Bull. 1459. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 26 p.

YEAR 1973

ABST A report of two studies. In the first, spores of (a) Fomes annosus, (b) Peniophora gigantea, and (c) Trichoderma species were trapped in 18 pine plantations and natural stands from New Hampshire to Florida between September; 1967 and October 1968. Deposition of spores of (a) and (b) was least between June and October and was inversely correlated with temperature. In another study, stumps in two newly-thinned young slash and loblolly plantations were inoculated with (a). Stump colonization was greatest during autumn and winter and least in spring and summer; no colonization occurred in stumps inoculated in July and August. The

stumps were also examined for the presence of (b) and (c), neither of which showed any seasonal pattern of occurrence. After 5 years, losses in the residual stand in the slash plantation were significantly correlated with the percentage of stumps infected 2 months after stump inoculation; losses in the loblolly plantation were negligible. It is concluded that thinning in spring and summer is a practical and effective means of controlling (a).

KEYW Diseases, loblolly, plantation, slash pine, South

429 AUTH Roth, F.A.,II
TITL Thinning pine stands for top returns.
PUBL Circular ANR-396. Auburn, AL: Alabama Cooperative Extension Service, Auburn University. 3 p.
YEAR 1983
ABST Properly done, thinning results in increased quality and economic potential.
KEYW Economics, natural stand, pulpwood, row thinning

430 AUTH Rummer, R.B.
TITL Analysis of the productivity, costs, and site impacts of a second generation small-log skidder.
PUBL Moscow, ID: University of Idaho, Graduate School. [Number of pages unknown]. M.S. thesis.
YEAR 1982
ABST A low-horsepower, rubber-tired skidder designed for the efficient removal of thinning residues has been developed at the University of Idaho. This thesis draws on the results of two previous small-log skidder projects: a computer simulation model and testing of the original miniskidder design. The project continues with the testing and analysis of an improved design.
KEYW Damage, economics, machinery, models, skidder

431 AUTH Sakai, H.; Kamizaka, M.
TITL Prehauling systems for logs from thinnings.
PUBL Journal of the Japanese Forestry Society. 67(3): 82-91.
YEAR 1985
ABST Analysis of the mechanics and operational efficiency of a manual prehauling system (downhill), and two methods using portable radio-controlled winches.
KEYW Machinery, selective thinning

432 AUTH Samset, I.; Bjaanes, H.
TITL Full tree strip thinning.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry. [Number of pages unknown].
YEAR 1969
ABST Logging systems are adapted to early thinnings in Norway.
KEYW Damage, felling, machinery, processing, selective thinning, skidder, strip thinning, systems, whole-tree

433 AUTH Sander, I.L.; Rogers, R.
TITL Growth and yield of shortleaf pine in Missouri: 21-year results from a thinning study.
PUBL In: Proceedings of symposium for the management of pines of the interior South; 1978 November 7-8; Knoxville, TN. Atlanta, GA: U.S. Department of Agriculture, Forest Service: 14-27.
YEAR 1978
ABST Net cubic foot and board foot volume yields of 30-year-old shortleaf pine stands thinned twice at 10-year intervals to the same basal area were significantly higher when thinned to a basal area of 90 square feet per acre or more than when thinned to lower densities. The density at which periodic annual net volume growth was greatest increased with time. Basal area growth was lowest for plots thinned to a basal area of 50 square feet per acre and varied little for plots at higher densities. The presence of hardwoods reduced growth and yield by 8 to 12 percent.
KEYW Growth and yield, shortleaf, silviculture, South

434 AUTH Santesson, M.; Sjunnesson, S.
TITL Simulation model for thinning machines.
PUBL Rep. 49. Stockholm, Sweden: Royal College of Forestry. Department of Operational Efficiency. [Number of pages unknown].
YEAR 1972
ABST In 1967, a research and development project called "full mechanization of the first thinning" was started at the Department of Operational Efficiency at the Royal College of Forestry, Stockholm. The present work forms part of this project. Part 1 of the report gives an account of alterations and an extension made to a computer program for a simulation model of thinning systems. The model has been simplified and the program has, to a large degree, been rewritten in order to suit the available data processing system better. In addition to this, the model has been modified so that it is also able to simulate a thinning system where the thinning machine can simultaneously handle several trees on the felling head (bouquet-handling). Part II is composed of a series of simulation tests with models of bouquet-handling of trees.
KEYW Feller-buncher, machinery, models, systems

435 AUTH Sarles, R.L.
TITL Production and cost--chainsaw fellings in hardwood thinnings.
PUBL Northern Journal and Timber Processor. 34(2): 24-57.
YEAR 1985
ABST Four overstocked hardwood stands were thinned by three man crews. Production rates were determined from tree volume and felling times per tree for given distances between successively felled trees. Production costs were also calculated.
KEYW Felling, hardwood, limbing, selective thinning

436 AUTH Sarles, R.L.; Wartluft, J.L.; Whiteneck, K.R.
TITL Chain saw felling in hardwood thinnings.
PUBL In: Proceedings of Harvesting the South's small trees; 1983 April 18-20; Biloxi, MS. Madison, WI: Forest Products Research Society: 58-65.

YEAR 1984
ABST Production and efficiency rates were computed from time study and stem measurement data from four hardwood thinning operations in the central Appalachians. Felled trees averaged 9 to 10 inches in d.b.h. and 38 to 45 feet in merchantable length. Hourly production rates were determined from a regression equation expressing productive felling time as a function of merchantable volume and distance between successively felled trees. The average production rate for the combined operations was 2.4 cords per hour at an average felling efficiency of 49 percent. Efficiency was inversely related to delay time. Causes of delay--the largest time block in each felling cycle--were analyzed. Specialized training in thinning methods and techniques was recommended to increase worker efficiency and productivity.
KEYW Felling, hardwood, methods, South

437 AUTH Sarna, R.P.
TITL Husqvarna thinning saw workshop.
PUBL APA Tech. Rel. 80-R-47. Washington, DC: American Pulpwood Association. 2 p.
YEAR 1980
ABST A sponsored workshop on the use of the Swedish thinning saw. The saw cuts trees of up to a 3-inch diameter with one cut and up to a 6-inch diameter with two cuts.
KEYW Felling, machinery, methods, training

438 AUTH Sarna, R.P.
TITL Seven islands thinning operation.
PUBL APA Tech. Rel. 77-R-53. Washington, DC: American Pulpwood Association. [Number of pages unknown].
YEAR 1977
ABST An account of thinning spruce and fir in Maine, attempting to make commercial operations in these stands feasible, felling by different methods and debarking on site of small trees. This, the first real project of its type, needs work but has potential.
KEYW Felling, systems

439 AUTH Sassaman, R.W.; Barrett, J.W.; Twambly, A.D.
TITL Financial precommercial thinning guides for northwest ponderosa pine stands.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST Financial precommercial thinning guides for Pacific Northwest ponderosa pine stands are reported for an infinite number of combinations of crop tree size and vigor, site quality, thinning costs, stumpage prices, and three discount rates. These guides are the result of a cooperative effort between the Pacific Northwest Forest and Range Experiment Station and Region Six of the National Forest System. The guides represent a flexible forest management tool that is based on financial returns from increased timber production expressed as benefit per cost ratios; they are of most use to National Forest system managers.
KEYW Economics, precommercial thinning, site, West

440 AUTH Savage, M.
TITL Getting fat off thinning.
PUBL Timber Harvesting. 34(12): 36-37.
YEAR 1986
ABST Description of plantation thinning operations performed with a Makeri 34T.
KEYW Equipment, plantation, processing, red pine

441 AUTH Savelle, I.W.
TITL A simulation model for thinning plantations.
PUBL Mississippi State, MS: Mississippi State University, Department of Forestry. 117 p. M.S. thesis.
YEAR 1982
ABST The computer simulation model was developed to evaluate the production of mechanized thinning systems. The model deals primarily with felling, skidding, and loading stems. The model provides a stand generator and marking routines. Production estimates are based on input variables.
KEYW Felling, skidder

442 AUTH Schaap, L.
TITL Is full-tree logging an economic method for producing fuel from noncommercial thinnings?
PUBL Nederlands Bosbouwtijdshkamp. 57(4): 134-142.
YEAR 1985
ABST Cost and yields of this method were compared to other methods of noncommercial thinnings in dense young stands of Scots pine and Douglas-fir. However, at the present price of fossil fuel, green chips cannot be produced competitively from small material.
KEYW Economics, precommercial thinning, whole-tree

443 AUTH Schallau, C.H.
TITL An economic analysis of accelerating road construction in the Bureau of Land Management's Tillamook Resource Area.
PUBL Res. Pap. PNW-98. Portland, OR: U.S. Department of Agriculture, Pacific Northwest Forest and Range Experiment Station. 29 p.
YEAR 1970
ABST Acceleration of road construction in the Bureau of Land Management's Tillamook Resource Area would not be economically feasible. Although doubling the current rate of construction would increase thinning yields, added stumpage revenues would not compensate for higher interest, timber sale administration, and maintenance charges. In fact, investment in such a plan would earn a minus 1.25-percent rate of return.
KEYW Economics, roads, West

444 AUTH Schechtner, K.
TITL The Brossaur method--a new harvesting technique using a wheeled tractor.
PUBL Allgemeine Forstzeitschrift. 96(2): 32-33.

YEAR 1985
ABST A report on an Australian system which extracts whole stems through felling and skidding to a forest road. Features include a two-man chain saw, wheeled skidders or agricultural tractors equipped with double-drum winches, and extensive use of remote control and radio communications during thinning operations or harvesting of large timber.
KEYW Felling, skidder, whole-tree

445 AUTH Schmitt, D.; Bower, D.R.
TITL Volume tables for young loblolly, slash, and longleaf pines in plantations in south Mississippi.
PUBL Res. Note SO-102. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 6 p.
YEAR 1970
ABST Data in 7-year-old plantations are the basis for tables of total cubic-foot volume, inside bark, for loblolly, slash, and longleaf pine ranging from 1 to 8 inches in diameter.
KEYW Loblolly, longleaf, slash pine, South, volumes

446 AUTH Schnekenburger, F.; Brown, K.M.; Barker, J.E.
TITL Effects of nitrogen fertilization and low thinning on snow damage in jack pine.
PUBL Forest Science. 31(3): 552-556.
YEAR 1985
ABST A nitrogen fertilization-thinning trial was established in a 12-year-old stand of jack pine. Treatments consisted of two levels of nitrogen-fertilization and two levels of low thinning. Snow damage was analyzed and it was concluded that nitrogen-fertilized trees, because of their longer needles, accumulated more snow and as a result suffered heavier snow damage than did trees that received no nitrogen. Low thinning reduced the size of the population at risk to snow damage, but it had no effect on the distribution of trees among four classes of snow damage severity.
KEYW Damage, fertilization

447 AUTH Scholander, J.
TITL Vegetation wear-tested with an electronically equipped tractor.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 151-155.
YEAR 1969
ABST An account of how to get the most out of the soil surface in Sweden before breaking it into pieces. Description of large soil deformations, including vegetation and test equipment.
KEYW Damage, machinery, site

448 AUTH Schroering, J.S.; Lanford, B.L.; Stokes, B.J.
TITL Franklin 105 feller-buncher: fifth-row thinning application.
PUBL Southern Journal of Applied Forestry. 9(2): 110-113.
YEAR 1985
ABST Franklin 105 feller-buncher equipped with a Tidewater DL-12 accumulating shear was studied in a fifth-row thinning application to determine

variables affecting machine operation and productivity. Production costs were higher for selective thinning than for row/corridor harvesting.
KEYW Damage, feller-buncher, plantation, spacing

449 AUTH Schultz, R.P.
TITL Part 2. Intensive culture of southern pines: maximum yields on short rotations.
PUBL Iowa State Journal of Research. 49(3): 325-337.
YEAR 1975
ABST For maximal pine-volume growth on most sites in the South, at least 750 healthy southern pine seedlings should be planted where competing vegetation has been destroyed but where topsoil and organic matter have not been removed from the immediate rooting zone. By use of 1-0 planting stock and present planting techniques, early mortality will average 30 percent. Interplanting, even 1 year after initial planting, will not improve yields unless the replanted patches exceed one-tenth of an acre. Fertilization (combined with intensive cultivation, water control, and genetic improvement) can greatly increase the productive potential of southern pines. A minimal basal area of 100 square feet should be maintained in pole-sized stands to ensure maximal growth. Thinnings before the age of 25 cannot be expected to improve yields, but may be advantageous if large-product sizes are required.
KEYW Growth and yield, silviculture, South

450 AUTH Scott, R.W.S.
TITL Application of line thinnings in practice.
PUBL South African Forestry Journal. 102: 67-72.
YEAR 1977
ABST The discussion covers the need to change our present system of harvesting pine timber thinnings in order to increase productivity. The author points out that this productivity increase can only be achieved through technical innovation and by the introduction of machinery suited to do the job. The machinery and work methods call for a type of neutral thinning in conjunction with a selective thinning or followed by a selective thinning. The advantages of this type of thinning are illustrated, as practiced in South Africa.
KEYW Machinery, row thinning, selective thinning, strip thinning

451 AUTH Sessions, J.
TITL Logging techniques in mountains of Jamaica.
PUBL Unasylva. 26(105): 18-22.
YEAR 1974
ABST Analysis of costs for thinning and clear cutting in subtropical, mountainous Carib pine plantation and comparison of the use of two pieces of light equipment, one truck-mounted, and the other on skids, for skyline logging.
KEYW Cable system, clearcut, economics, equations, plantation, steep slopes, systems, volumes

452 AUTH Seymour, R.S.; Ebeling R.A.; Gadzik, C.J.
TITL Operational control density control in spruce-fir sapling stands--production of a mechanical swath cutter and brush-saw workers.

PUBL CFRU Res. Note 14. Orono, ME: University of Maine, College of Forest Resources. 26 p.
YEAR 1984
ABST Discussion of combined mechanical and manual thinning which appears to be an efficient means of reducing stand density in young stands without sacrificing residual stand quality.
KEYW Damage, precommercial thinning

453 AUTH Seymour, R.S.; Gadzik, C.J.
TITL A nomogram for predicting precommercial thinning costs in overstocked spruce-fir stands.
PUBL Northern Journal of Applied Forestry. 2(2): 81-83.
YEAR 1985
ABST A simple graphical method is described for quickly estimating costs of precommercial thinning using brush saws in dense young stands. The effects of varying stand density, labor, costs, and prior treatment by mechanical felling of swaths can be analyzed.
KEYW Economics, precommercial thinning, strip thinning

454 AUTH Shartle, S.A.
TITL An analysis of southern plantation characteristics relevant to future equipment design.
PUBL Blacksburg, VA: Virginia Polytechnic Institute and State University, School of Forestry and Wildlife, Industrial Forestry Operations Program. [Number of pages unknown].
YEAR 1977
ABST Over three-quarters of southern softwood will be harvested from plantations by the year 2000. Plantation parameters are relevant to the choice of equipment. Equipment design is analyzed. Data collected at over 50 percent of southern plantations were secured by an industry questionnaire which investigated spacing, acreage, age, slope, tree size, and trafficability and gathered information on present and expected plantation harvesting systems. After analysis of annual production, use of advanced equipment and use and form of wood harvested, the only harvest problem illuminated is for small tracts on lower coastal plain. The analysis provides information on equipment design criteria to aid in development of more productive plantation harvesting machinery.
KEYW Forecasts, harvester, machinery, plantation, South, spacing, systems

455 AUTH Shelton, M.G.; Switzer, G.L.
TITL The development of unthinned loblolly pine plantations at various spacings.
PUBL In: Thinning southern pine plantations: Proceedings of southern forest economic workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 53-54.
YEAR 1980
ABST Results of spacing at 5 by 5, 7 by 8, and 9 by 10 feet are discussed at age 20. Mean tree size is larger at 9 by 10 than at 5 by 5 feet by 40 percent for d.b.h., 110 percent for stem volume, and 100 percent for

crown. Differences in growth and spacing are Rep.ed. Stem quality was lower in a 9 by 10 foot spacing. A density of 700 to 800 trees per acre was reasonable utilization of site.

KEYW Growth and yield, loblolly, plantation, South, spacing

456 AUTH Shepherd, R.K., Jr.
TITL Biological constraints to thinning practice.
PUBL New Zealand Journal of Forestry Science. 6(2): 152-157.
YEAR 1976
ABST Biological factors, both inherent to the individual tree and caused by tree-site interactions, impose constraints on thinning practice. The very fast early growth rate of radiata pine makes early thinning desirable to avoid problems of competition, disease and insect susceptibility, and instability to wind. Correct silvicultural techniques have been devised to meet many of these problems and tree breeding offers solutions to others. However, there are still many natural risk factors that cannot be avoided, but can be minimized by careful planning.
KEYW Damage, diseases, growth and yield, plantation, silviculture

457 AUTH Shepherd, R.K., Jr.
TITL Growth of thinned and non-thinned loblolly pine stands.
PUBL Louisiana Agriculture. 17(4): 10-12.
YEAR 1974
ABST Comparison is made of growth of several stands, thinned and non-thinned, at different spacings with emphasis on rapid production of high-quality sawlogs.
KEYW Economics, growth and yield, loblolly, plantation, selective thinning, South, spacing

458 AUTH Shepherd, R.K., Jr.
TITL Ice storm damage to thinned loblolly pine plantations in northern Louisiana.
PUBL Southern Journal of Applied Forestry. 2(3): 83-85.
YEAR 1978
ABST A single ice storm caused heavy damage to row-thinned loblolly pine stands during the preceding year, but more than 200 undamaged trees per acre were left in all stands. A second ice storm the following year virtually destroyed half of the stands and left only a marginal number of trees in those remaining. Stands thinned from below suffered only light damage.
KEYW Damage, loblolly, plantation, row thinning, South

459 AUTH Shepherd, R.K., Jr.
TITL Thinning practice in Australian plantations.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 69-77.
YEAR 1969
ABST Thinning techniques in Australian plantations are based on European concepts but have been adapted to suit local conditions. Where climatic conditions are mild, both native and exotic species grow fast and

require relatively early and severe thinning regimes to promote the growth of selected final crop trees. Although much emphasis in thinning technique is directed towards favoring those selected trees, the aim is to obtain reasonable financial returns from each thinning.

KEYW Growth and yield, methods, radiata pine, slash pine

460 AUTH Shibuya, K.
TITL Logging techniques in thinnings today and tomorrow in Japan.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 93-94.
YEAR 1969
ABST Discussion of thinning applied in planted forest, thinnings beginning at age 15, and selective thinning in Japan, where two-thirds of the forest is on steep slopes.
KEYW Forecasts, plantation, selective thinning, systems

461 AUTH Shirley, J.W.; Coker, R.J.
TITL Scheduling silviculture at Kaingaroa.
PUBL New Zealand Journal of Forestry. 30(2): 194-198.
YEAR 1985
ABST In order to produce large diameter sawlogs with a small defect core, each individual crop tree must be pruned at an age which will minimize the defect core diameter and have minimal effect on subsequent growth. A scheduling system for silvicultural treatment has been developed using a forest database into which field measurements of individual stands are input. The data are used in a height forecasting system that models the monthly variation in height growth and estimates the expected predominant mean height for pruning.
KEYW Pruning

462 AUTH Shoulders, E.
TITL Growth of slash and longleaf pines after cultivation, fertilization, and thinning.
PUBL Res. Note SO-59. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 3 p.
YEAR 1967
ABST In a study in central Louisiana, pines of commercial size were thinned and then fertilized and cultivated annually. Objectives of the test were to determine how seed production and growth responded to these intensive practices. This note reports effects on growth. Volume growth of slash pines of pulpwood and sawlog size was decreased by disking and heavy thinning and increased by fertilization. Diameter growth was boosted by fertilization and heavy thinning, but space was decreased by disking. Similar but less marked results were obtained with longleaf.
KEYW Fertilization, growth and yield, longleaf, silviculture, slash pine

463 AUTH Sirois, D.L.; Stokes, B.J.
TITL Production and cost of the Makeri harvester.
PUBL In: Proceedings of harvesting the South's small trees; 1983 April 18-20; Biloxi, MS. Madison, WI: Forest Products Research Society: 133-138.

YEAR 1984
ABST A small Finnish harvester, a Makeri 33T, was evaluated during thinning of loblolly pine in southern Louisiana. Production data were obtained to determine the effect of harvesting procedures and product length on production. Spacings between narrow 12-foot-wide corridors ranged from 30 to 100 feet. Equations were determined to estimate production and cost.
KEYW Economics, harvester, loblolly, machinery, South

464 AUTH Sjunnesson, S.
TITL Simulation, a tool for evaluating mechanized thinning systems.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 254-266.
YEAR 1969
ABST A simulation model can help choose the best thinning schedule and machine system in any type stand and give an estimate of profitability of operation.
KEYW Machinery, models, processor

465 AUTH Sjunnesson, S.
TITL Some remarks on logging systems for the first commercial thinning of a stand.
PUBL In: Proceedings of a symposium on the mechanization of harvesting of small-sized wood and logging residues; 1969 Jan 30; [Place of meeting unknown]. FAO/ECE/LOG/REV. [Place of publication unknown]: [Publisher unknown]. [Number of pages unknown].
YEAR 1969
ABST (Manual) power saw felling and limbing and piling were 80 percent of the system cost and forwarding costs accounted for the remaining 20 percent.
KEYW Chipping, economics, machinery, processing, row thinning, shortwood, systems

466 AUTH Skelly, J.M.; Alexander, S.A.; Bradford, B.M.
TITL Predicting the infection level in loblolly pine stands as caused by Heterobasidion annosus.
PUBL In: Proceedings of the American Phytopathological Society; 1977 August 14-18; Blacksburg, VA: Virginia Polytechnic Institute and State University: 120-121. Vol. 4.
YEAR 1978
ABST Roots of loblolly pine were evaluated for infection by Heterobasidion annosus after extraction from 1-foot cube of soil taken from the center of 0.05-acre plots in 16 plantations in Virginia, North Carolina, and Georgia: other measurements included tree height, crown class, d.b.h., symptom rating, m.a.i. since thinning, soil texture, stand basal area, and conks of Heterobasidion annosus. Finally, root systems of all trees in the sample plots were excavated and evaluated for infection. Lengths of healthy and infected roots in the 1-foot cube of soil and in the whole plot were the same (85 percent and 15 percent, respectively). Further analysis of all data may lead to a nondestructive sampling system.
KEYW Diseases, growth and yield, loblolly, plantation

467 AUTH Skold, B.O.
TITL The future potential market for thinning machines.
PUBL Res. Note 65. Stockholm, Sweden: Department of Operational Efficiency, Royal College of Forestry. 2 p.
YEAR 1974
ABST Inventory of existing thinning stands is taken and analyzed. Productivity and costs of mechanized systems to thin these stands is analyzed and the future market for thinning machines estimated.
KEYW Economics, forecasts, forwarder, harvester, machinery, processor, shortwood, systems, whole-tree

468 AUTH Smalley, G.W.; Bailey, R.L.
TITL Yield tables and stand structure for loblolly pine plantations in Tennessee, Alabama, and Georgia highlands.
PUBL Res. Pap. SO-96. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 81 p.
YEAR 1974
ABST Tables are given showing expected cubic-foot yields, basal area, average height, and number of stems per acre by 1-inch diameter classes for all combinations of: planting density 500 to 2,500 trees per acre in increments of 250; site index (base age 25) 40 to 70 feet in steps of 10; age from seed 10 to 40 years by intervals of 5.
KEYW Equations, growth and yield, loblolly, plantation, South

469 AUTH Smith, C.R.; Johnson, J.D.; Riley, L.F.
TITL Economics of precommercial thinning of jack pine.
PUBL Gen. Tech. Rep. PNW-194. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 12 p.
YEAR 1986
ABST Precommercial thinning trials were established in 1970 in 9- and 22-year-old jack pine stands managed for sawlog production in northern Ontario. Stocking, density, height, and d.b.h. were recorded before thinning and 10 years after treatment.
KEYW Precommercial thinning

470 AUTH Smith, H.W.; Baird, C.O.
TITL Results of thinning in a 27-year-old eastern white pine plantation on the southern Cumberland Plateau of Tennessee.
PUBL In: Proceedings of symposium for the management of pines of the interior South; 1978 November 7-8; Knoxville, TN. Atlanta, GA: U.S. Department of Agriculture, Forest Service: 143-150.
YEAR 1978
ABST In a 27-year-old eastern white pine plantation near Sewanee, Tennessee, thinning twice at 11-year intervals increased board foot growth 150 percent, but did not increase cubic foot growth compared to an unthinned plot. Thinning three times at 7-year intervals caused a 110 percent increase in board foot growth, but a decrease of 81 percent in cubic foot growth. A mean average increment of 800 board feet per acre may be anticipated with thinning on average sites on the southern Cumberland Plateau of Tennessee. These data are unreplicated.

KEYW Diseases, growth and yield, plantation, precommercial thinning, pruning, site, South

471 AUTH Smith, N.J.
TITL A model of stand allometry and biomass allocation during the self-thinning process.
PUBL Canadian Journal of Forest Research. 16: 990-995.
YEAR 1986
ABST A growth model is developed to describe the relationship between any measure of size and number of stems in even-aged, monospecific plant populations during self-thinning. Allometric relationships between plant dimensions are shown to change over time, finally approaching a stable value defined by a generalized self-thinning rule. A new approach for constructing stand density programs is presented.
KEYW Biomass, models, silviculture

472 AUTH Smith, W.D.; Hafley, W.L.
TITL Evaluation of a loblolly pine plantation thinning model.
PUBL Southern Journal of Applied Forestry. 10(1): 52-63.
YEAR 1986
ABST The model, which can simulate row thinning and row thinning from below or for spacing, was mathematically derived from a bivariate unthinned plantation yield model. The model was tested using data from thinning studies across the natural range of loblolly pine and showed the model to be accurate and consistent.
KEYW Loblolly, row thinning

473 AUTH Somberg, S.I.; Haas, R.E.
TITL Heavy thinnings can increase income from east Texas loblolly pine stands.
PUBL Texas Forestry Pap. 10. Nacogdoches, TX: Stephen F. Austin State University, School of Forestry. 4 p.
YEAR 1971
ABST A study of thinning on 17-year-old loblolly stands which gives soil characteristics and treatments.
KEYW Economics, growth and yield, loblolly, natural stand, selective thinning, South

474 AUTH Sommerville, M.C.; Lanford, B.L.; Stokes, B.J.
TITL Mechanized piling during pine plantation thinning.
PUBL Forest Products Journal. 34(4): 45-49.
YEAR 1984
ABST Piling cut bolts is necessary when utilizing forwarders during southern pine plantation thinning. Although often done manually, piling may also be accomplished using machinery. A small three-wheeled machine, the Morbell logger, seems particularly well-suited for this task. In this study, the productivity and costs of the logger are examined while piling. Multiple linear regression techniques were used to estimate piling time per tree based on time study data collected in the summer of 1981. Costs per hour were developed and combined with productivity rates to determine cost per unit of production. It was concluded that

piling time per tree was significantly influenced by the number of cut and residual trees per acre. Also, larger piles could be built as efficiently as smaller ones. No statistically significant effects could be found between bolt length or slope and piling time; however, the logger was observed to have difficulty in negotiating slopes greater than 20 percent.

KEYW Economics, forwarder, plantation, selective thinning

475 AUTH Speechly, H.T.; Helms, J.A.

TITL Growth and economic returns after precommercial thinning nonuniform white-fir stands in California.

PUBL Forest Ecology and Management. 11: 111-130.

YEAR 1985

ABST Problems associated with describing young-growth stands and modeling their growth following thinning are examined. The study indicated that precommercial thinning can be a highly profitable operation which, depending on the prescription chosen, may give a net increase in the stand's present net worth.

KEYW Economics, models

476 AUTH Spurr, S.H.

TITL Row thinnings.

PUBL In: Proceedings of Society of American Foresters; 1947 December 17-20; Minneapolis, MN. Washington, DC: Society of American Foresters: 370-377.

YEAR 1947

ABST Many overstocked stands of timber remain unthinned because of the cost and technical difficulty of silvicultural treatment. By cutting out rows or strips, effective release can frequently be obtained economically. Row thinnings of several types have been tried in pine and spruce plantations of the Harvard forest with excellent results. The method is particularly useful in first thinning and should prove applicable under a wide variety of forest conditions.

KEYW Economics, plantation, row thinning, strip thinning

477 AUTH Staaf, A.

TITL Present and planned research and development work on logging techniques in thinning in Sweden.

PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 249-251.

YEAR 1969

ABST Research project in Sweden is outlined.

KEYW Economics, forecasts, machinery, models, systems

478 AUTH Stajniak, J.

TITL Harvesting techniques in thinnings--today and in the future.

PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry. [Number of pages unknown].

YEAR 1969

ABST Axes were used for felling and debarking in Poland. Developing trends include tree length and mechanization.
KEYW Chipping, forecasts, systems

479 AUTH Stanek, W.; Hopkins, J.C.; Simmons, C.S.
TITL Effects of spacing in lodgepole pine stands on incidence of atropellis canker.
PUBL Forestry Chronicle. 62(2): 91-95.
YEAR 1986
ABST Thinning is recommended for controlling cankers giving acceptable growth and yield at site index of 59 to 69 feet.
KEYW Diseases, growth and yield

480 AUTH Sterle, J.R.
TITL Case 450 and S.A. Allen 16" shear.
PUBL APA Tech. Rel. 73-R-44. Washington, DC: American Pulpwood Association. 4 p.
YEAR 1973
ABST Gives brief technical details for this combination of front-end loader and 16-inch shear, which was used for line thinning in a 15-year-old slash pine plantation in Florida. Price $21,000 U.S.
KEYW Feller-buncher, loading, machinery, methods

481 AUTH Stewart, I.
TITL Fitting an Igland winch to a Clark skidder.
PUBL Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1982
ABST A different approach for mounting an Igland Compact 5000/2H to a Clark Ranger 664B skidder is described.
KEYW Machinery, skidder, systems

482 AUTH Stockel, J.
TITL Technological studies on a cable crane/processor combination.
PUBL Wissenschaftliche Dresden. 33(3): 229-230.
YEAR 1984
ABST A report on a mobile cable crane and trimmer/cross cutter designed by the Austrian Federal Forest Service and used in thinning a 65-year-old stand on steep slopes.
KEYW Cable system, equipment, steep slopes

483 AUTH Stokes, B.J.
TITL Flail delimbing of loblolly pine--a case study.
PUBL Res. Note SO-315. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 7 p.
YEAR 1985
ABST Flail delimbing was tested using a prototype flail mounted on a Clark skidder in loblolly pine. Production rates and cost were determined by comparing skidding-flailing with skidding only.
KEYW Economics, processor, skidder

484 AUTH Stokes, B.J.
TITL Productivity of chain saws, feller-bunchers, and bobtail truck loading on thinning pine plantations.
PUBL Mississippi State, MS: Mississippi State University, Department of Agricultural and Biological Engineering. 54 p. M.S. thesis.
YEAR 1978
ABST Thinning operations were studied to determine production rates for different equipment. Functions studied were chain saw felling, chain saw felling-limbing-bucking, feller-bunchers, and bobtail truck loading. Prediction equations were developed for the functions. The equations were used to develop production tables.
KEYW Feller-buncher, felling, limbing, plantation, pulpwood, shortwood, South

485 AUTH Stokes, B.J.; Koger, J.L.; Pickle, F.J.
TITL Mor-bell logger: skidding case study.
PUBL Res. Note SO-290. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 4 p.
YEAR 1983
ABST A production equation was developed for the Mor-bell logger for skidding while thinning a loblolly pine plantation. Production and costs for skidding and iron gate delimbing were determined for a range of operating conditions.
KEYW Economics, loblolly, machinery, plantation, processing, skidder

486 AUTH Stokes, B.J.; Lanford, B.L.
TITL Evaluation of Timbco Hydro-buncher in southern plantation thinning.
PUBL Transactions of the ASAE. St. Joseph, MI: American Society of Agricultural Engineers. 28(2): 378-381.
YEAR 1985
ABST A swing feller-buncher was evaluated for thinning loblolly pine on level terrain up to 58 percent slope. Production estimates were developed for the machine working up and down and across the slope. Also, the time to fell and bunch to the front and rear of the machine was estimated/recorded.
KEYW Feller-buncher, felling, harvester, loblolly, pulpwood

487 AUTH Stokes, B.J.; Lanford, B.L.
TITL Evaluation of Timbco Hydro-buncher in southern plantation thinning.
PUBL ASAE Pap. 83-1600. St. Joseph, MI: American Society of Agricultural engineers. 11 p.
YEAR 1983
ABST A swing feller-buncher was field-evaluated for thinning loblolly pine on level terrain up to 58 percent slope. Production estimates were developed for the machine to operate up, down, and across slopes and on level ground. Also, the effect of piling to the front and to the rear was examined in all the models.
KEYW Feller-buncher, loblolly, machinery, steep slopes

488 AUTH Stokes, B.J.; Lanford, B.L.
TITL Manual delimbing and bucking of bunched wood in thinnings.

PUBL Forest Products Journal. 37(3): 23-26.
YEAR 1987
ABST Chain saw delimbing and bucking of bunched trees was studied for five thinning operations. Prediction equations were developed for each element of the function. Total delimbing and bucking time per tree was significantly affected by average d.b.h. and bolt length. Productivity and cost analyses were completed. Average production was 3.6 cords per productive machine hour at a cost of $4.63 per cord.
KEYW Feller-buncher, forwarder, limbing, loblolly, methods

489 AUTH Stokes, B.J.; Lanford, B.L.
TITL Patterns and equipment for selective thinning.
PUBL In: Proceedings on Workshop on thinning southern pine plantations; 1982 May 24-26; Long Beach, MS. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. [Number of pages unknown].
YEAR 1982
ABST Discussion and debate over the reasons for and expected results of thinning southern pines continues. A prevalent question concerns the selection of systems and techniques for obtaining the desired results. A comparison of five patterns is made: third row, ninth row, selective with skidder, selective with yarder, and selective with forwarder.
KEYW Cable system, economics, forwarder, machinery, row thinning, selective thinning, silviculture, skidder, systems

490 AUTH Stokes, B.J.; Lanford, B.L.
TITL Prebunching and skidding functions in thinnings.
PUBL ASAE Pap. 85-1594. St. Joseph, MI: American Society of Agricultural Engineers. 9 p.
YEAR 1985
ABST Prebunching with a logger was tested in loblolly pine plantation thinning. Trees were skidded with the logger using narrow (9.84 feet) corridors. The trees were consolidated into large bundles for removal with a grapple skidder using wider corridors. Production rates were developed for the logger and the skidder.Skidder production included skidding and iron gate delimbing. A cost analysis was completed.
KEYW Bunching, skidder

491 AUTH Stokes, B.J.; Lanford, B.L.
TITL Production and cost of manual delimbing, bucking, and piling in thinnings.
PUBL Res. Pap. SO-223. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 11 p.
YEAR 1986
ABST Studies were made of chain saw delimbing and bucking with manual piling of bunched trees to determine productivity rates and costs for each function.
KEYW Economics, feller-buncher, felling, limbing

492 AUTH Stokes, B.J.; Lanford, B.L.
TITL Timbco feller-buncher visits the South.

PUBL APA Tech. Rel. 83-R-91. Washington, DC: American Pulpwood Association. 2 p.
YEAR 1983
ABST The Timbco model 2518 hydro-buncher was evaluated and design features are discussed. Preliminary results indicated a productivity of 144 trees per hour.
KEYW Feller-buncher, loblolly, machinery, plantation

493 AUTH Stokes, B.J.; Lanford, B.L.; Sirois, D.L.
TITL Mor-bell thinning system: feller-buncher, skidder, and loader.
PUBL ASAE Pap. 82-1590. St. Joseph, MI: American Society of Agricultural Engineers. 12 p.
YEAR 1982
ABST The Mor-bell feller buncher and logger were field-evaluated in thinning loblolly pine plantations. Prediction equations were developed for the different functions. A productivity and cost analysis was completed for the Mor-bell system.
KEYW Economics, feller-buncher, loading, loblolly, machinery, plantation, skidder, South, systems

494 AUTH Stokes, B.J.; Sirois, D.L.
TITL Operational characteristics of a harvester in intermediate cutting.
PUBL In: Jones, Earle P., Jr., ed. Proceedings of the second biennial southern silvicultural research conference: 1982 November 4-5; Atlanta, GA. Gen Tech. Rep. SE-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 240-246.
YEAR 1982
ABST The felling and processing capabilities of the Makeri 33T, a small Finnish harvester, were evaluated in a thinning operation in a southeast Louisiana loblolly plantation. Cutting patterns tested were selective thinning with and without access corridors. The effect of product length on production was also evaluated. Regression analyses were used to establish production rates for the alternatives. Highest production was for tree-length product length at close corridor spacing. Residual stand damage and soil compaction were measured for each operating procedure. There was a slight soil bulk density increase in areas where the machine operated. An average of 32 percent of all residual trees per acre had some type of bole damage.
KEYW Damage, harvester, selective thinning

495 AUTH Strickland, J.R.
TITL Logging techniques in thinning today and tomorrow in the Southeastern United States.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; September 1969; Stockholm, Sweden: Royal College of Forestry. [Number of pages unknown].
YEAR 1969
ABST The stands intended for thinning in the Southeastern United States are generally planted pine stands with 1,300 to 2,100 trees per hectare and an average d.b.h. of about 13 to 17 centimeters. The choice of logging techniques is different for the large industrial forest owner and the small tract owner--the two main owner categories in the Southern United

States. Techniques used today are predominately manual operations incorporating a very low degree of mechanization. The management objectives of the small tract owner vary greatly, but, generally speaking, the aim is for a multiproduct output. A considerable part of the wood produced will be acquired through thinning--mainly selective thinning, even in the future. Mechanization will probably be comparatively slow. For the large industrial owner, aiming mainly at pulpwood production, thinning will be a questionable measure in the future. Economic restrictions will make thinning impossible unless it can be mechanized drastically. Several prototype machines are available; these show considerable promise for row or swath thinning.

KEYW Forecasts, machinery, methods, multiproduct, row thinning, selective thinning, South

496 AUTH Strickland, J.R.

TITL Matching equipment to the thinning task--current options and potential products including thinnings for energy.

PUBL In: Thinning southern pine plantations: Proceedings of southern forest economics workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 69-77.

YEAR 1980

ABST Discussion of when thinning equipment and personnel need to travel onsite. Thinning is defined: below, crown, selective, and mechanical. More information is needed to select among options, especially thinnings for energy.

KEYW Economics, longwood, shortwood, systems

497 AUTH Strub, M.R.; Burkhart, H.E.

TITL A class-interval-free method for obtaining expected yields from diameter distributions.

PUBL Forest Science. 21(1): 67-69.

YEAR 1975

ABST Yields per unit area can be estimated from diameter frequency predictions. Frequencies are usually predicted for arbitrarily chosen diameter class intervals. Dependence on class intervals may be eliminated by computing yield as the product of the expected volume of a single tree in a given stand times the number of trees per unit area in that stand. Examples of this class-interval-free method for obtaining yields are presented for the cases where the transformed Beta and Weibull are assumed to be the population density for tree diameter at breast height.

KEYW Growth and yield, volumes

498 AUTH Strub, M.R.; Feduccia, D.P.; Baldwin, V.C.,Jr.

TITL A diameter distribution method useful in compatible growth and yield modeling of thinned stands.

PUBL In: Barnett, James P., ed. Proceedings of the first biennial southern silvicultural research conference; 1980 November 6-7; Atlanta, GA. Gen. Tech. Rep. SO-34. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 127-130.

YEAR 1981

ABST Two growth and yield forecasting techniques have been combined to develop equations that predict the change in diameter distribution in thinned loblolly pine plantations. The equations are based on the concept of compatible growth and yield applied to a diameter distribution model for unthinned loblolly pine plantations. This produces a generalization of the unthinned equations that projects size distribution in thinned plantations. The forecasts are compared with stand tables from a thinned plot from a spacing-thinning study located at Merryville, Louisiana.

KEYW Growth and yield, loblolly, models, plantation, South

499 AUTH Stuart, W.B.; Perumpral, J.V.; Walbridge, T.A.; Shartle, S.A.

TITL Pine plantation data for future equipment design.

PUBL Transactions of the ASAE. St. Joseph, MI: American Society of Agricultural Engineers. 30: 568-571,578.

YEAR 1981

ABST Results of three different surveys are presented and discussed. Surveys concerned the extent of existing southern pine plantations, their site preparation techniques, planting spacings, and projected harvesting plans.

KEYW Machinery, plantation, South, spacing, volumes

500 AUTH Stulen, J.A.

TITL Forwarders in smallwood?

PUBL LIRA Rep. 8(1). Rotorua, New Zealand: Logging Industry Research Association. 4 p.

YEAR 1983

ABST A look at forwarders and systems for their use. Features of purpose-built forwarders are briefly summarized. Forwarder with skidder systems are compared and factors affecting the productivity of forwarder systems are examined. Based on the work studies done, guidelines are given for improving forwarder productivity in thinning systems.

KEYW Economics, forwarder, machinery, methods, radiata pine, row thinning, shortwood, systems

501 AUTH Sullivan, A.D.

TITL Loblolly pine growth and yield in the Mid-South.

PUBL In: Proceedings of the symposium on the loblolly pine ecosystem (west region); 1984 Mar. 20-22; Jackson, MS. [Place of publication unknown]: [Publisher unknown]. [Number of pages unknown].

YEAR 1984

ABST Very sophisticated growth and yield models have been developed and applied to loblolly pine, but model application varies with stand conditions. Predictions for even-aged natural stands and unthinned old-field plantations are reasonably comprehensive. Information is available for thinned plantations, but no adequate model for thinned plantations on prepared sites is available. Present and future research efforts will extend the coverage of state-of-the-art models to more stand types and incorporate modern management practices.

KEYW Growth and yield, loblolly, models, plantation, volumes

502 AUTH Sullivan, A.D.; Clutter, J.L.
TITL A simultaneous growth and yield model for loblolly pine.
PUBL Forest Science. 18(1): 76-86.
YEAR 1972
ABST A model to project cubic-foot volume from initial age, site index, and basal area is developed for natural stands of loblolly pine. For a projection period of zero years, the model predicts current yield and is thus a simultaneous growth and yield model. Statistical procedures to obtain a single estimate of the parameters of the model, using data from remeasured plots, are considered under two assumptions about the error correlations of such data. Parameter estimates for each case are obtained and compared, using data from the Eastern Forest Experiment Station's loblolly pine stand density study. Parameter estimates for a basal area projection model are also obtained. When taken together, these fitted models are a numerically consistent set of prediction equations for cubic-foot yield, cubic-foot volume projection, and basal area projection.
KEYW Growth and yield, loblolly, models, South

503 AUTH Sullivan, A.D.; Williston, H.L.
TITL Growth and yield of thinned loblolly pine plantations in loessial soil areas.
PUBL Tech. Bull. 86. Mississippi State, MS: Mississippi State University. 16 p.
YEAR 1977
ABST Age, site index, basal area, and volume before and after thinning were determined for stands of loblolly pine which were established at high initial density (more than 1,000 stems per acre) on abandoned farm land between 1929 and about 1970. Data were used to predict the growth and yield of stands of varying site class and initial basal area using the Sullivan/Clutter model. The estimates are used to predict the yield at age 35 of a 15-year-old stand of 130 square feet per acre basal area thinned to a residual basal area of (a) 80, (b) 100, or (c) 110 square feet per acre at ages 15, 21, and 28. The predicted yields were (a) 4,681 cubic feet per acre, (b) 4,990 cubic feet per acre, and (c) 5,124 cubic feet per acre.
KEYW Growth and yield, loblolly, plantation, South, systems

504 AUTH Sundberg, U.
TITL Interim report on study of the full mechanization of the first thinning.
PUBL Rep. 43. Stockholm, Sweden: Department of Operational Efficiency, Royal College of Forestry. 18 p.
YEAR 1970
ABST A summary is given of results when about half of the project has been carried out. The purpose is to explore problems of the first thinning in fully mechanized forestry. Manual felling or handling are excluded. Review includes a survey of man-machine systems, trials of machine components, work on prototype machines, and total optimization of first thinning.
KEYW Economics, machinery, row thinning, spacing, strip thinning, systems

505 AUTH Sutton, W.R.
TITL Comparison of alternative silvicultural regimes for radiata pine.
PUBL New Zealand Journal of Forestry Science. 6(2): 350-356.
YEAR 1976
ABST Unthinned radiata pine plantations on long rotations incur serious risk of insect or disease attack. Economic analysis of a silvicultural regime that incorporated a production thinning revealed that a pulpwood thinning contributed a negligible net return and had the effect of substantially extending the rotation. This led to the development of an alternative regime giving similar volume yields, but economically and silviculturally superior. This regime incorporated wide initial spacing, heavy early thinning (without yield) and severe pruning.
KEYW Damage, diseases, economics, growth and yield, pruning, silviculture, spacing, volumes

506 AUTH Tamm, C.O.
TITL Site damages by thinning due to removal of organic matter and plant nutrients.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 175-179.
YEAR 1969
ABST A discussion of loss of nutrients and organic matter and its effect on the forest with respect to different soil types from Sweden.
KEYW Damage, fertilization, silviculture, site, whole-tree

507 AUTH Taylor, H.T.
TITL Automated thinning for southern pine plantations--a concept.
PUBL ASAE Pap. 71-178. St. Joseph, MI: American Society of Agricultural Engineers. 22 p.
YEAR 1971
ABST The concept of an automated system for felling thinnings in southern pine tree plantations is described and a conceptual design is developed. Trees are felled by a machine without an operator and the machine is guided by tree locations and by tree spacings in the stand.
KEYW Felling, machinery, plantation, row thinning, South, spacing

508 AUTH Taylor, S.C.
TITL A model for evaluating the suitability of fixed shear harvesting machines for selectively thinning plantations.
PUBL Mississippi State, MS: Mississippi State University, Department of Forestry. 73 p. M.S. thesis.
YEAR 1980
ABST A Fortran computer simulator model was written to evaluate fixed shear harvesting machines for thinning plantations. The model simulated a rubber-tired, articulated machine selectively thinning a plantation. Machine performance was evaluated by the number of marked trees missed and unmarked trees that were cut. Results indicated factor improving performance.
KEYW Feller-buncher, machinery, models, plantation, selective thinning, spacing

509 AUTH Taylor, S.C.; Matthes, R.K.; Weaver, G.H.; Watson, W.F.
TITL A model for evaluating the suitability of fixed shear harvesting machines for selectively thinning plantations.
PUBL ASAE Pap. 79-1598. St. Joseph, MI: American Society of Agricultural engineers. 18 p.
YEAR 1979
ABST A stand model was used to generate plantations to test the impact of length of the machine, width of the machine, and angle of articulation on the effectiveness of thinning. The results of this study indicated that the most effective machine should be as narrow as is feasible and have a maximal articulation angle, and the most effective plantation should have at least 10-foot row spacing with straight rows and trees accurately spaced within rows.
KEYW Feller-buncher, machinery, models, plantation, selective thinning, spacing

510 AUTH Tessier, J.P.
TITL Logging techniques in thinnings today and tomorrow.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry. [Number of pages unknown].
YEAR 1969
ABST Increasingly, thinning is being applied in the forests of the North American west coast. A significant feature of the forests intended for thinning there, is that the trees are comparatively big. A typical figure for logs produced in thinnings is 12 to 15 cubic feet per piece. Because topography generally is steep, the main attention in logging development is paid to cable systems. A special skyline system has been developed for thinnings. A typical thinning layout in 30- to 50-year-old stands consists of clear-cut skyline roads 12 to 20 feet in width at the tail tree. These strips or skyline roads are spaced 200 to 300 feet apart, generally perpendicular to the road and extending 600 to 1,000 feet, depending on deflection. Trees marked for thinning in the intervening strips are felled towards or away from the skyline road, generally at about a 45-degree angle to the skyline road. For the future, the author stresses the need for equipment that is lighter, more mobile, and hopefully less expensive, and also the need for highly skilled labor and management.
KEYW Cable system, methods, steep slopes, West

511 AUTH Thomas, C.E.; Birdsey, R.; McWilliams, W.
TITL The small timber resource in the Midsouth.
PUBL In: Proceedings of harvesting the South's small trees; 1983 April 18-20; Biloxi, MS. Madison, WI: Forest Products Research Society: 18-28.
YEAR 1984
ABST An analysis of coastal pine forest region revealed 40 billion of that total in merchantable poletimber. Nearly 1.3 billion tons of material are represented in poletimber and an additional half billion tons in sapling-size trees. Detailed analysis tables summarize timber availability by ownership, management opportunity class, and proportion of softwood and hardwood stocking. Diameter distributions and future prospects are also covered briefly.
KEYW Forecasts, South, volumes

512 AUTH Thomas, C.E.; Hedlund, M.S.
TITL Thinning opportunities in the Midsouth during the 1980's.
PUBL In: Thinning southern pine plantations; Proceedings of forest economic workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 27-52.
YEAR 1980
ABST Report on the plantations, their inventory, acreage available, current volumes, and basal area. A projection is developed of number of acres for commercial thinning.
KEYW Forecasts, plantation, South, volumes

513 AUTH Tufts, D.M.
TITL Effects of tree size on felling and bunching with Rome Industries' accumulator shear.
PUBL APA Tech. Rel. 77-R-4. Washington, DC: American Pulpwood Association: 6 p.
YEAR 1976
ABST Time study to develop a logging system in which small timber will not adversely affect the cost of logging and that provides a safer method than chain saws.
KEYW Bunching, feller-buncher, felling, systems

514 AUTH Tufts, D.M.
TITL Factors influencing the economics of thinning pine plantations.
PUBL Timber Harvesting Rep. 3. Gulfport, MS: National Space Technology Lab. 51 p.
YEAR 1977
ABST Eight different logging systems for thinning pine plantations are described and the advantages and disadvantages of each system are discussed in relation to several factors that influence production and logging costs. Tree size is the most important factor and tables showing costs per cord by d.b.h. have been worked out for each logging system. The stump-to-stump system, using the bobtail truck and chain saw, looks as good as most of the mechanized or semimechanized systems. The whole tree chip system and the treeslength system, using a feller-buncher, delimbing gate, and grapple skidder, appear to have the most promise for utilizing small-size trees.
KEYW Chipping, economics, feller-buncher, longwood, plantation, skidder, systems, whole-tree

515 AUTH Tufts, R.A.; Sirois, D.L.; Stokes, B.J.
TITL Productivity and cost of grapple skidders performing gate delimbing.
PUBL In: Proceedings of the fourth biennial southern silvicultural research conference; 1986 November 4-6; Atlanta, GA. Gen. Tech. Rep. SE-42. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 313-318.
YEAR 1987
ABST Six different types of skidders were studied in clearcut and thinning applications. Regression analysis was used to develop total time cycle equations. Estimates of cost per cord were also developed.
KEYW Clearcut, economics, models, plantation, skidder

516 AUTH Tufts, R.A.; Stokes, B.J.
TITL Productivity of rubber-tired, grapple skidders performing gate delimbing.
PUBL In: Proceedings of the 1986 Society of American Foresters National Convention; 1986 October 5-8; Birmingham, AL. Bethesda, MD: Society of American Foresters: 348-352.
YEAR 1987
ABST Time study data were collected on grapple skidders performing gate delimbing in clearcuts and thinnings. Equations were developed to predict total cycle time.
KEYW Clearcut, equations, limbing, skidder

517 AUTH Tufts, R.A.; Tufts, D.M.
TITL Harvesting loblolly pine.
PUBL In: Proceedings of the symposium on the loblolly pine ecosystem (west region); 1984 March 20-22; Jackson, MS. [Place of publication unknown]: [Publisher unknown]: [Number of pages unknown].
YEAR 1984
ABST Seven typical harvesting systems used in loblolly pine stands are described with their advantages, disadvantages, and best application. Productivity and indexed cost data are also presented.
KEYW Economics, harvester, loblolly, machinery, methods, systems

518 AUTH Tustin, J.R.; Terlesk, C.J.; Fraser, T.
TITL Thinning in New Zealand Radiata pine plantations. Future practices and research needs.
PUBL New Zealand Journal of Forestry Science. 6(2): 333-349.
YEAR 1976
ABST Tending practice, being a function of management, depends as much on the economic and physical background in New Zealand as on silvicultural objectives to produce maximum volume or value yields. The background facts relevant to plantation practice in New Zealand include a massive planting program with a concomitant silvicultural commitment, a large involvement by non-State agencies, an urgent need to diversify export markets, often steep terrain, and high labor and machinery costs. Tending practice that has been proven in the area for radiata pine is limited. This is why many different silvicultural regimes have been proposed, but few have survived. The simple plant and clearfell regime has been applied most widely. For this reason the principles to adopt in deciding how the species should be grown and harvested are most important. Suggested principles are: define the target tree taking into consideration markets, profitability and the technical requirements of wood quality; minimize growing costs; simplify management wherever possible but without sacrificing market flexibility; and reduce as much as possible biological, physical, management, and market risk. The background facts and these principles suggest a sawlog final crop is logical for most New Zealand plantations, and trends indicate it will normally be grown on a rotation of 20 to 30 years. A proportion of the resource will be pruned to 6 m and stockings will be relatively low in these stands. Production thinning is unlikely in steep country but the practice will continue in state forests while old regimes grow through

to rotation end. Some private organizations will continue production thinning because they believe it is in their interest to do so. Future developments in production thinning are likely to include a geometric approach to tree removal, a relaxation of unnecessarily rigid specifications, intensive method improvement, and adoption of skidding machinery that has high productivity in relation to its capital cost. Research must continue to focus on overall evaluation of the growing and harvesting system. This will highlight priorities for micro-economic research by a balanced multidisciplinary team. Principal targets in the Forest Research Institute program have a bias towards silviculture and clearfelling, but this is seen to be appropriate.

KEYW Economics, forecasts, growth and yield, machinery, plantation, silviculture, steep slopes

519 AUTH Van Lear, D.H.; Goebel, N.B.; Williams, J.G., Jr.

TITL Performance of unthinned loblolly and slash pine plantations on three sites in South Carolina.

PUBL Southern Journal of Applied Forestry. 1(4): 8-10.

YEAR 1977

ABST The performance of adjacent unthinned plantations of loblolly and slash pine on three sites in South Carolina was evaluated after 16 growing seasons. Sites ranged from a noneroded piedmont soil to an excessively drained sandy soil of the sandhills physiographic region. Growth and survival varied widely between sites, with greatest productivity occurring in the piedmont and the lowest in the Congaree sandhills. Despite the droughty nature of the latter site, survival after 16 growing seasons was over 80 percent for both species. On a volume basis, loblolly pine outperformed slash pine at the upper piedmont and Aiken plateau sites, while slash pine was superior on the dry sandhills site. Incidence of fusiform rust was much higher for both species at the Aiken plateau than at the other sites.

KEYW Diseases, growth and yield, loblolly, plantation, site, slash pine, South

520 AUTH Van Lear, D.H.; Saucier, J.R.; Williams, J.G., Jr.

TITL Growth and wood properties of longleaf pine following silvicultural treatments.

PUBL Journal of Soil Science Society of America. 41(5): 989-992.

YEAR 1977

ABST Combinations of treatments were applied to 0.08-hectare plots in a 28-year-old longleaf pine plantation (average basal area 33.6 square meters per hectare in South Carolina in early 1973: (a) thinning to residual basal area 11.5, 18.4 and 25.3 square meters per hectare: (b) fertilizing with 90 kilograms per hectare P and 168 kilogram per hectare N: and (c) prescribed burning before (a) or (b). Data are tabulated for: d.b.h., basal area, and height increments, and widths of early and late wood and annual rings in 1973 and 1974; soil and foliar nutrient contents in late 1974; and wood density at breast height before and 2 years after treatment. Radial increment was significantly increased by (a), while (b) caused a smaller short-term increase; responses resulted from formation of late and early wood respectively, so that wood density was increased by thinning. Growth was not affected by (c).

KEYW Fertilization, growth and yield, longleaf, plantation, silviculture

521 AUTH Vasilev, V.D.
TITL The "Pioneer" light cableway with a single-drum winch.
PUBL Gorsko Stopanstvo. 40(1): 29-33.
YEAR 1984
ABST Details of design, specifications, and use of this machine are given. Developed in Bulgaria for extracting thinnings downslope, the two-man machine is powered by a Husqvarna 162 chain saw engine.
KEYW Machinery

522 AUTH Von Althen, F.W.; Stiell, W.M.; Forster, R.B.
TITL Effects of four thinnings on the growth, yields, and financial returns of a 62-year-old red pine plantation.
PUBL Forestry Chronicle. 54(5): 253-260.
YEAR 1978
ABST Growth data for a 62-year-old plantation of red pine at Rockland, Ontario, part of which was thinned four times between 1938 and 1972, and part of which was left unthinned, are presented for the two stand conditions, together with associated product yields and economic implications of alternative treatments. The investment in thinning, when based on historical costs and revenues, was attractive; the thinning program increased net present worth at each stage. When based on current costs and revenues, with no increase at an assumed inflation rate, the investment in thinning was less attractive, and it was not proved conclusively that the thinning program would be profitable. Financial growth peaked at a rotation age of approximately 50 years.
KEYW Economics, growth and yield, plantation, red pine

523 AUTH Vuokilam, Y.
TITL The effect of a radical thinning program on growth and yield.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 118-122.
YEAR 1969
ABST Radical thinning refers to a exceptionally heavy thinning. Only theoretical calculations are available at this time.
KEYW Damage, growth and yield, silviculture

524 AUTH Vuokilam, Y.
TITL Present thinning practice in Finland.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 78-82.
YEAR 1969
ABST Types of trees to be thinned, intensity of thinning, and weight of thinning trees are discussed.
KEYW Methods, selective thinning, silviculture

525 AUTH Wakeley, P.C.
TITL Single commercial thinnings in slash and loblolly pines.
PUBL Journal of Forestry. 68(4): 223.
YEAR 1970

ABST Three 1-acre squares were planted with loblolly pine, one acre each at 8- by 8-, 6- by 6-, and 5- by 5-foot spacings. Later these tests were duplicated with slash pine. Thinning on each plot was both heavy and light. Final comparisons indicated that the wide spacing with less thinning was financially preferable.

KEYW Diseases, loblolly, plantation, slash pine, South, spacing, volumes

526 AUTH Wakeley, P.C.

TITL Single commercial thinnings in variously spaced slash and loblolly pine plantations.

PUBL Res. Pap. SO-48. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 12 p.

YEAR 1969

ABST In mid-June of 1940, the Southern Forest Experiment Station applied light and heavy thinnings to slash pines that had been planted the winter of 1924-25 at spacings of 8 by 8, 6 by 6, and 5 by 5 feet. Early in March 1942, it made similar thinnings in loblolly pines that had been planted at the same spacings in 1922-23. Final measurements were at age 30 in the slash plantations, and at age 34 in the loblolly. The thinnings could not be shown to have significantly affected the pulpwood yields within any one spacing of either species. Nevertheless, their simultaneous application to three spacings, the comparison with unthinned controls, and their final measurement at the end of practicable pulpwood rotations have provided information not available from previous studies of shorter duration.

KEYW Growth and yield, loblolly, methods, plantation, slash pine, South, spacing, volumes

527 AUTH Walbridge, T.A.; Stuart, W.B.

TITL Sensitivity of thinning cost to equipment, site, and stand conditions.

PUBL In: Thinning southern pine plantations: Proceedings of Southern forest economic workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 17-123.

YEAR 1980

ABST Study of effect on production of method of thinning. A bobtail system was used for harvesting. Felling rates were determined for Bush combine, Bobcat, John Deere, and TJ-30 felling machines.

KEYW Economics, felling, methods, South, systems

528 AUTH Wambach, R.F.

TITL Compatibility of mechanization with silviculture.

PUBL Journal of Forestry. 67(2): 104-108.

YEAR 1969

ABST The upward turn in mechanization has raised some concern over the practice of silviculture. In this paper, it is argued that silviculture must be flexible. Two approaches are discussed, one to use machines as a silvicultural tool, the other to modify our silvicultural goals and practices to accommodate mechanization. There is compatibility of mechanization with silvicultural choices regarding spacing in plantations and stocking levels.

KEYW Machinery, row thinning, silviculture, spacing

529 AUTH Ware, L.M.; Stahelin, R.
TITL Growth of southern pine plantations at various spacings.
PUBL Journal of Forestry. 46(4): 267-274.
YEAR 1948
ABST Before engaging in the long-term enterprise of tree planting, landowners rightly want clear-cut advice on what species to plant, what spacing to use, and how to treat the growing plantation to obtain the greatest revenue. Contributions to this knowledge are reported from 14-year-old experimental plantations of southern pines at Auburn, Alabama.
KEYW Economics, growth and yield, loblolly, longleaf, plantation, selective thinning, slash pine, South, spacing

530 AUTH Waring, R.H.; Pitman, G.B.
TITL Modifying lodgepole pine stands to change susceptibility to mountain pine beetle attack.
PUBL Ecology. 66(3): 889-897.
YEAR 1985
ABST The premise that mature forests of lodgepole pine are susceptible to attack by mountain pine beetle when physiologically stressed was tested by manipulating the canopy density and availability of nitrogen in a 120-year-old forest. Where canopy density was reduced, surviving trees significantly increased their resistance over a 3-year period. Increased resistance was reflected by changes in wood production per unit of leaf area.
KEYW Damage

531 AUTH Watson, W.F.; Taylor, S.C.; Weaver, G.H.; Matthes, R.K.
TITL Impact of feller-bunchers and plantation spacing on thinning.
PUBL Southern Journal of Applied Forestry. 9(2): 117-120.
YEAR 1985
ABST A simulation model was used to examine the effectiveness of rubber-tired articulated machines for felling trees selectively marked for thinning. The model contains three elements: thinning from below to produce a uniform residual stand; a stand routine allowing variation in age and spacing; and a movement element for feller-bunchers where length, width, and angle of articulation can be varied.
KEYW Feller-buncher, machinery, selective thinning

532 AUTH Watson, W.F.; Weaver, G.H.; Karr, B.L.; Matthes, R.K.
TITL Cost efficiency of Southern thinning systems.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST Two timber harvesting systems are currently being used to thin pine plantations in the Southern United States. One system is labor intensive and more costly, but can accomplish selective thinnings. The labor intensive system favors growth of superior trees of sawtimber and plywood quality. The more mechanized system can selectively thin only after corridors are established by row thinnings and is less expensive. Current cost of thinning operations, current price for stumpage, and a

tree growth simulator were used to compare the cost of these thinning systems over the rotation of loblolly pine plantations.
KEYW Damage, economics, labor, pulpwood, row thinning, selective thinning

533 AUTH Weaver, G.H.; Kluender, R.A.; Watson, W.F.; Reynolds, W.; Matthes, R.K.
TITL 1979 Pulpwood Producer Census.
PUBL Unnumbered series. Southwest and Southeast technical division of the American Pulpwood Association. Washington, DC: American Pulpwood Association. 11 p.
YEAR 1981
ABST Overall census of pulp production in the East, with comparison to other regions of country.
KEYW Pulpwood

534 AUTH Wells, C.G.
TITL Double-drum winches in thinnings.
PUBL LIRA Rep. 6(1). Rotorua, New Zealand: Logging Industry Research Association. 4 p.
YEAR 1981
ABST Operation of single-drum and double-drum winches is compared and evaluated. Potential for use of the double-drum winch in New Zealand is considered.
KEYW Machinery, row thinning, selective thinning, skidder

535 AUTH Wells, C.G.; Jorgensen, J.R.
TITL Nutrient cycling in loblolly pine plantations.
PUBL Quebec, Canada: Les Presses de L'Universite Laval. 21 p.
YEAR 1975
ABST Report of quantitative studies in five old-field plantations of loblolly pine in North and South Carolina during 1962-72. The stands were 5 to 39 years old, but most of the information presented refers to one 16-year-old stand. Data are given on the accumulation and distribution of biomass and nutrients (N, P, K,Ca, Mg) in the stand and soil, including some data for roots. Nutrient requirements and transfer rates to litter, soil, etc. are estimated for the 16-year-old stand. The effects of thinning on litter composition, litter fall, and throughfall are reported and discussed, showing an increase on the rate of nutrient release from litter deposited during and after thinning, with little effect on the older litter.
KEYW Biomass, loblolly, plantation, South

536 AUTH Wells, C.G.; Jorgensen, J.R.; Burnette, C.E.
TITL Biomass and mineral elements in a thinned loblolly pine plantation at age 16.
PUBL Res. Pap. SE-126. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 10 p.
YEAR 1975
ABST Description of a study in North Carolina of 16 sample trees from a 16-year-old loblolly pine plantation to determine and analyze the stand biomass, its components and their content of mineral elements. The tree biomass (including roots) was found to be 192 tons per hectare, with

mineral contents of 321 kilograms of nitrogen, 48 kilograms of potassium, 239 kilograms of calcium and 68 kilograms of magnesium. Analysis of a pulpwood thinning showed that the 22 tons per hectare of logging residue contained more nitrogen than the pulpwood, but that the quantities of other elements were similar to those in the pulpwood. Clearfelling the plantation at age 16, and removing all the aboveground material, would deplete the biomass at the rate of 9.8 tons per hectare per year, and deplete nitrogen, phosphorus, potassium, calcium, and magnesium at rates of 16, 2, 10, 12, and 3 kilograms per hectare per year. This rate of removal might exceed the annual replenishment rate for some nutrients, and might therefore deplete nutrients and fertility on some sites.

KEYW Biomass, clearcut, damage, fertilization, loblolly, plantation, silviculture, site, South

537 AUTH Wenger, K.F.; Evans, T.C.; Lotti, T.; Cooper, R.W.; Brender, E.V.
TITL The relation of growth to stand density in natural loblolly pine stands.
PUBL Res. Pap. 97. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 10 p.
YEAR 1958
ABST Progress report on growing space requirements for natural stands of loblolly pine. Effects are measured of residual stand density, obtained naturally or by cutting, during intermediate ages, upon volume yield and total production. Net return may be calculated and used to determine optimal levels of stand density for various combinations of site, product, and financial goal.
KEYW Growth and yield, loblolly, natural stand, South

538 AUTH Whayman, A.
TITL Present and planned research and development work on logging techniques in thinnings in Great Britain.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 252-253.
YEAR 1969
ABST Trend to increased mechanization with rising labor cost has highlighted need for further research. A list of projects is included.
KEYW Economics, machinery, processor, roads, row thinning

539 AUTH Whipple, S.D.
TITL Early thinnings from pine plantations.
PUBL Progress Rep. Series 85. Auburn, AL: Agricultural Experiment Station, Auburn University. 3 p.
YEAR 1962
ABST Large acreages of pine plantation have been established by many landowners over the past two decades. New plantations are continually being established while older plantations are ready for cutting. Some key questions that the landowner must answer are: (1) what original planting spacing will prove most profitable, (2) what type of cutting or thinning should be followed and when should they be carried out, and (3) what financial return will be realized? Answers to these questions vary with circumstances of particular owners, and all cannot be covered in a restricted number of tests. Data presented represent results obtained

from tests made on the Fayette Experiment Forest of Auburn University Agricultural Experiment Station. Conditions involved are typical of upper coastal plain small acreage plantations.
KEYW Loblolly, row thinning, selective thinning, spacing, volumes

540 AUTH Whipple, S.D.
TITL Producing fence posts from thinning.
PUBL Circ. 137. Auburn, AL: Agricultural Experiment Station, Auburn University. 1 p.
YEAR 1960
ABST Dense natural pine stands averaging 4 to 5 inch d.b.h. may be thinned profitably for posts. Benefits are listed.
KEYW Multiproduct, natural stand

541 AUTH Wiant, H.V.
TITL Form class estimates--a simple guide.
PUBL Journal of Forestry. 70(7): 421-422.
YEAR 1972
ABST Description and discussion of the "Wiant-F-C-Wedge," which is a simple device that facilitates rapid form-class estimations.
KEYW Volumes

542 AUTH Wiant, H.V.; Walker, L.C.
TITL Cacodylic acid silvicides for thinning loblolly pine and controlling hardwoods.
PUBL In: Proceedings of the 22nd annual meeting of the Southern Weed Science Society. [Date of meeting unknown]. Raleigh, NC: Southern Weed Science Society: 260-262.
YEAR 1969
ABST As single injections, cacodylic acid silvicides have been Rep.ed to show promise for precommercial thinning of conifers and elimination of hardwoods. Three studies were done using loblolly pine. Each was treated with a 30-percent cacodylic acid silvicide. Three weeks after treatments, it appeared that excellent kills would be obtained, and 96 percent of the trees showed some crown kill. After 2 years, kills, with approximately 20 trees per treatment, were relatively poor, especially at lower dosages. These results emphasize the need for considerable delay before success of silvicide treatments can be accurately evaluated. Also, greater dosages than used in the study may provide more satisfactory kills.
KEYW Chemicals, hardwood, loblolly, precommercial thinning, South

543 AUTH Williams, D.F.
TITL Quantity and distribution of forest fuels following first thinning in radiata pine plantations.
PUBL Forestry Tech. Pap. 26. Victoria, Australia: Forests Commission. 3 p.
YEAR 1977
ABST Stands under two thinning regimes, A and B, were compared with unthinned stands, 12 years old, in northeast Victoria: A = 1-in-3 row thinning and B = 1-in-6 row thinning with selection between rows. Merchantable volume removed was 9.3 cubic meters in A and 10.3 cubic meters in B.

Thinning reduced total tree fuels from 126 to 87 tons per hectare ovendry weight in A and from 127 to 83 tons per hectare in B, but increased total ground fuels from 28 to 46 tons per hectare ovendry weight in A and from 22 to 48 tons per hectare in B.

KEYW Machinery, plantation, row thinning, selective thinning

544 AUTH Williamson, R.A.
TITL The levels-of-growing-stock studies.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST The effects of thinning on stand growth are examined for various levels of growing stock at various ages.
KEYW Growth and yield, selective thinning, spacing, West

545 AUTH Williamson, R.A.
TITL Precommercial thinning.
PUBL In: Proceedings of symposium on management of young pines; 1974 December 3-5; Charleston, SC. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 72-76.
YEAR 1974
ABST Precommercial thinning in overstocked stands of loblolly pine is discussed using a study in south Arkansas as background. Twenty years of growth and stand development information is presented and some observations are made about the results.
KEYW Growth and yield, loblolly, precommercial thinning, South

546 AUTH Williston, H.L.
TITL Growth and yield to age 37 in north Mississippi loblolly plantations.
PUBL Southern Journal of Applied Forestry. 3(3): 127-130.
YEAR 1979
ABST Loblolly pine plantations on site 80 and site 90 (base age 50) were thinned three times at 5-year intervals to basal areas (BA) of 70 and 100 square feet per acre beginning at age 17 years. Total production per acre after 20 years of management was: site 90, BA 70--5,274 cubic feet or 16,925 board feet (international 1/4-inch rule); site 90, BA 100--6,215 cubic feet or 18,910 board feet; site 80, BA 70--4,390 cubic feet or 10,643 board feet; and site 80, BA 100--4,692 cubic feet or 9,230 board feet. Heavy thinning reduced cordwood yield 15 percent on site 90 and 6 percent on site 80.
KEYW Growth and yield, loblolly, plantation, selective thinning, South

547 AUTH Williston, H.L.
TITL Pros and cons of row thinning pine plantations.
PUBL Pulpwood Products and Saw Mill Logging. 20(6): 46.
YEAR 1972
ABST Row thinning has both advantages and disadvantages. Some of its advantages are: it simplifies the marking of trees, makes mechanical thinning possible, and merchantable wood is removed more easily. Some disadvantages are: rows that are not easily identifiable cause a

problem, row thinning removes genetically superior trees, it removes unmerchantable trees, and the average diameter of the stand is reduced. The conditions of each stand must also be considered.
KEYW Marking, plantation, row thinning

548 AUTH Williston, H.L.
TITL A statistical history of tree planting in the South, 1925-1979.
PUBL Misc. Rep. SA-MR 8. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southeastern Area, State and Private Forestry. [Number of pages unknown].
YEAR 1980
ABST Acres planted each year are listed by State, broken down into categories of: (1) Federal land, (2) other public land, (3) industry, and (4) nonindustrial private. Totals are listed for all the States, along with the number of acres planted by State and year under the Agricultural Conservation Program, Forestry Incentives Program, and Conservation Reserve Soil Bank Program.
KEYW Plantation, South

549 AUTH Williston, H.L.
TITL Thinning desirable in loblolly pine plantations in west Tennessee.
PUBL Res. Note SO-61. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 7 p.
YEAR 1967
ABST In loblolly pine plantations thinned at age 19 and at 5-year intervals thereafter, growth during the 10 years following the first thinning was independent of residual basal area within the range tested--67 to 174 square feet per acre. Thinning was economically attractive in 29-year pulpwood rotations and appeared necessary in longer rotations.
KEYW Economics, growth and yield, loblolly, plantation, South

550 AUTH Williston, H.L.
TITL Thinning shortleaf pine plantations in northern Mississippi.
PUBL Southern Journal of Applied Forestry. 2(4): 137-140.
YEAR 1978
ABST Residual basal areas did not have a significant effect on cubic volume growth over a 20-year period in a thinning study established in 23-year-old shortleaf pine plantations. Basal area at age 38 years did have a highly significant effect on board-foot volume growth during the ensuing 5-year period. Total production at 43 years averaged 12,334 board feet per acre on site 80. The results suggest that for sawtimber an 8- by 8-foot spacing would have been superior to the 6- by 6-foot spacing employed in establishing these plantations.
KEYW Growth and yield, methods, plantation, shortleaf, silviculture, South

551 AUTH Williston, H.L.; Balmer, W.E.
TITL Managing for natural regeneration.
PUBL Forest Farmer. 35(3): 6-12.
YEAR 1976
ABST On why and when to thin.
KEYW Natural stand

552 AUTH Williston, H.L.; Balmer, W.E.
TITL Managing for natural Virginia pine.
PUBL Rep. SA-FR-7. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. [Number of pages unknown].
YEAR 1980
ABST Discussion of general management procedures of Virginia pine, giving ages, spacing and methods for thinning with respect to use of stand (i.e., pulp or sawtimber).
KEYW Diseases, growth and yield, methods, precommercial thinning, pulpwood, silviculture, site, spacing, strip thinning

553 AUTH Williston, H.L.; Shropshire, F.W.; Balmer, W.E.
TITL Cypress management: a forgotten opportunity.
PUBL Report SA-FR-8. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. [Number of pages unknown].
YEAR 1980
ABST Discussion of general management of cypress, giving growth rate of several studies of thinned and unthinned stands.
KEYW Growth and yield, natural stand, plantation, silviculture, South, spacing

554 AUTH Wilson, R.V.; Watt, A.J.
TITL An economic comparison of alternative silvicultural treatments in radiata pine.
PUBL New Zealand Journal of Forestry Science. 6(2): 318-331.
YEAR 1976
ABST Economic comparisons have been made of a number of alternative silvicultural regimes in pinus radiata plantations in New South Wales, Australia. These comparisons, done with the aid of computer simulation, have indicated that relatively severe thinning regimes are financially preferable to those incorporating light and frequent thinnings, and that optimal financial rotations over a wide range of forest conditions are in excess of 45 to 50 years. The critical factors influencing the profitability are also discussed. For large plantation owners such as the forestry commission of New South Wales, it is not feasible to treat plantations by one optimal silvicultural regime. Meeting aggregate wood demands requires application of a number of alternative silvicultural regimes, some suboptimal, so that maximal benefits are obtained from the total plantation in a defined geographical zone.
KEYW Economics, plantation, silviculture

555 AUTH Wimble, A.W.
TITL Machine, time utilization, maintenance and cost-terms and concepts.
PUBL APA Tech. Rel. 81-R-42. Washington, DC: American Pulpwood Association. 24 p.
YEAR 1981
ABST List of basic terms and concepts used internationally to describe machine time, utilization and measures, and cost of maintenance.
KEYW Economics, machinery

556 AUTH Wimble, A.W.
TITL Thinning in the forestry of the future.
PUBL APA Tech. Rel. 73-R-53. Washington, DC: American Pulpwood Association. 7 p.
YEAR 1973
ABST Discussion of the why and how of thinning in the future, seven mechanized thinning systems, techniques for mechanized thinning, future potential for thinning machines, changes in silviculture, and mechanization of thinnings in Finland.
KEYW Equations, machinery, methods, silviculture, systems

557 AUTH Winsauer, S.A.; Kofman, P.D.
TITL Simulation of the Kockums 81-11 feller-buncher.
PUBL ASAE Pap. 86-1608. St. Joseph, MI: American Society of Agricultural Engineers. 11 p.
YEAR 1986
ABST A computer simulation model was developed following field trials with a Kockums 81-11 feller-buncher. The effects of stand density, d.b.h., row length, and thinning treatment on the Kockums feller-buncher productivity were analyzed. The simulation was also used to estimate productivity after changes in machine parameters such as shear rate, travel speed, and accumulator capacity.
KEYW Equipment, feller-buncher, strip thinning

558 AUTH Winsauer, S.A.; Mattson, J.A.; Thompson, M.A.
TITL Feller-bunchers in plantation thinnings: factors affecting productivity.
PUBL Res. Pap. NC-254. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 15 p.
YEAR 1984
ABST Simulation methods were used to determine the effect of various factors on the performance of feller-bunchers in thinning plantations. The variables considered were (1) stand characteristics: tree spacing, d.b.h., basal area, (2) operational factors: thinning pattern, thinning intensity, (3) machine characteristics: accumulating capacity, average travel speed, average shear time, average drop time, boom travel speed, and maximum and minimum boom reach. The use of an accumulator head and/or an increase in cutting speed was found to significantly improve productivity.
KEYW Feller-buncher, machinery, models, plantation, row thinning, strip thinning

559 AUTH Wippermann, H.J.
TITL Residual recovery in small scale forestry.
PUBL In: Proceedings of conference; 1984 June 15-21; Goteborg, Sweden: Applied Science Publishers: 26-34.
YEAR 1984
ABST Recent work on small-scale residue recovery and chipping operations in private forest in the German Federal Republic is described. The residues include small trees and tree segments from thinning operations and residual material from older stands to which different working and

harvesting methods have been applied. They are to be utilized as fuelwood or converted to chips or fuel.
KEYW Biomass, chipping, machinery, silviculture

560 AUTH Wippermann, H.J.
TITL Technology for the mechanized primary conversion of smallwood and forest residues.
PUBL Holz Als Roh-und Werkstoff. 43(1): 23-28.
YEAR 1985
ABST A review, based mainly on results of studies in central Europe, of smallwood harvesting methods, central conversion installations, and forest residue processing.
KEYW Biomass, processing, selective thinning

561 AUTH Wood, G.W.; Beland, J.M.; Lynn, T.E.
TITL Potential responses of wildlife habitat and populations to precommercial thinning in a young pine stand.
PUBL In: Proceedings of symposium on management of young pines; 1974 December 3-5; Charleston, SC. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 312-315.
YEAR 1974
ABST The authors can perceive no undesirable changes in wildlife habitat or populations as a result of precommercial thinning. Indeed, they believe there is an overall improvement in habitat, an increase in stand use by some animals, and an improvement in human usability.
KEYW Loblolly, precommercial thinning, wildlife

562 AUTH Woollons, R.C.
TITL Problems associated with analyses of long-term pine fertilizer x thinning experiments.
PUBL Australian Forest Research. 15(4): 495-507.
YEAR 1986
ABST Initial stand basal area and initial stocking are shown to be unsatisfactory covariants for analyses of thinning experiments combined with several fertilizer treatments. It is suggested that initial basal area per tree be used instead. Alternative methods of analyzing these experiments involve fitting projection equations to the plot yields, and subsequently analyzing the estimated coefficients by covariance or multivariate techniques.
KEYW Fertilization

563 AUTH Woolsey, T.S.
TITL Strip thinnings.
PUBL In: Proceedings of the Society of American Foresters; 6(1): 38-41.
YEAR 1911
ABST The idea proposed is to strip thin in a very dense spruce stand in New England. The system is explained and production given. An old article, but descriptive for that site.
KEYW Natural stand, Northeast, strip thinning, systems

564 AUTH Wright, J.P.
TITL First thinning options: row thinning vs. selection thinning.
PUBL New Zealand Journal of Forestry Science. 6(2): 308-317.
YEAR 1976
ABST A comparison of the relative merits of performing a first commercial thinning operation in radiata pine plantations by row thinning and by selection thinning from below. These two approaches are compared on the basis of silvicultural considerations (growth, quality and stability of the retained stems), economic and financial considerations (of both grower and harvester), and wood flow considerations. Row thinning is cheaper and easier than selection thinning, provides more scope for mechanization of harvesting, and reduces tree marking and supervision costs. On the debit side, it reduces the options for selecting crop trees for retention and reduces the yield of sawlogs in second thinnings. It is concluded that third row thinning is a practical and acceptable thinning technique for radiata pine, except for stands containing large numbers of defective trees, and possibly for stands particularly prone to damage by wind or snow.
KEYW Damage, economics, growth and yield, methods, row thinning, selective thinning, silviculture

565 AUTH Wright, J.P.; Opie, J.E.
TITL A short review of thinning practice in Victoria.
PUBL New Zealand Journal of Forestry Science. 6(2): 259-265.
YEAR 1976
ABST A brief review of thinning practice in each of the main wood-producing forest types of Victoria. It is seen that thinning practice varies a great deal between, and to a lesser extent within, forest types.Possible reasons for the variation in thinning practice are deduced, and the matter is further examined by reference to three case studies (ash-type eucalyptus, pine, and box-ironbark). It is concluded that, in Victoria, important determinants of thinning practice have been topography/access, various aspects of marketing, and the capacity of the forest resource.
KEYW Economics, methods, site

566 AUTH Wronski, E.B.
TITL Impact on tractor thinning operations on soils and tree roots in a Karri Forest, western Australia.
PUBL Australian Forest Research. 14: 319-332.
YEAR 1984
ABST Soils covering 23 percent of a trial area were visibly compacted or severely disturbed during thinning operations conducted by a forwarder and by a skidder. Eighteen months after logging, root length density in soil compacted by one or more passes by either vehicle was still only one-sixth of that in undisturbed soil.
KEYW Damage

567 AUTH Wu, S.C.; Tai, K.Y.
TITL Thinning and regeneration of China fir plantations in Taiwan.
PUBL In: The biological, operational, and economic aspects of thinning, worldwide: Proceedings of IUFRO meeting; 1977 September 12-16; Corvallis, OR: Oregon State University. [Number of pages unknown].
YEAR 1977
ABST Thinning to improve growth rate is an important process on plantations. Because silvicultural operations have become a kind of enterprise, cost and revenue have been calculated more carefully in recent years. With

ABST the increase in tree plantation area, the question whether the positive outcome of thinning can compare with its operational cost becomes important. Also, more effective forest renewal is desirable to assure faster growth rates. In this study a special design for regeneration is presented for more profitable thinning of China fir forests.
KEYW Economics, growth and yield, plantation, selective thinning, silviculture

568 AUTH Young, L.; Bowling, D.
TITL Total tree chipping in pine plantations.
PUBL In: Thinning southern pine plantations: Proceedings of southern forest economic workshop; 1980 March 3-5; Long Beach, MS. Raleigh, NC: Southern Forest Economics Workers: 78-86.
YEAR 1980
ABST Harvesting information on various cuts proposed during rotation, on blending field chips with residue chips, and on equipment and manpower used in chipping, including descriptions of third row thinning, strip thinning, final thinning.
KEYW Chipping, methods, plantation, row thinning, South, strip thinning, whole tree

569 AUTH Zahner, R.; Whitmore, F.W.
TITL Early growth of radically thinned loblolly pine.
PUBL Journal of Forestry. 58(8): 628-634.
YEAR 1960
ABST During 1954, a study was started in south Arkansas to determine if loblolly pine of good quality can be grown rapidly by giving choice trees full room. The early development of stems, crowns, and roots of such trees has been closely measured and compared to trees grown under more conventional thinning practices. The authors report the first 5 years of observation, but do not intend to recommend management procedures.
KEYW Growth and yield, loblolly, plantation, pruning, South, spacing

570 AUTH Zasada, Z.A.
TITL Feasibility of mechanized harvesting of thinnings in the Lake States.
PUBL In: Thinning and mechanization: Proceedings of IUFRO meeting; 1969 September; Stockholm, Sweden: Royal College of Forestry: 123-129.
YEAR 1969
ABST Discussion of red pine thinning and partial cutting in northern hardwood.
KEYW Damage, diseases, hardwood, machinery, red pine, row thinning, selective thinning, shortwood, silviculture, systems

571 AUTH Zasada, Z.A.
TITL Mechanized timber harvesting and forest management in northern Minnesota.
PUBL ASAE Pap. 71-613. St. Joseph, MI: American Society of Agricultural Engineers. 13 p.
YEAR 1971
ABST The effect of mechanized harvesting systems on the forest environment is discussed with the conclusion that, through planning the pattern of harvesting and selection of a logging system, forest management requirements can be included in the logging operation impact on costs and production.

KEYW Damage, economics, longwood, machinery, shortwood, silviculture, site, strip thinning, systems, whole-tree

572 AUTH Zasada, Z.A.; Benzie, J.W.
TITL Mechanized harvesting for thinning sawtimber red pine.
PUBL Misc. Rep. 99. St. Paul, MN: University of Minnesota, Agricultural Experimental Station. 14 p.
YEAR 1970
ABST Information is provided on harvesting systems that permit efficient use of machines compatible with multiple-use forest management. The study area was in Minnesota.
KEYW Machinery, silviculture, systems

573 AUTH Zobel, B.J.
TITL Forest Renewal on Industrial Timberlands.
PUBL Journal of Forestry. 72(11): 680-715.
YEAR 1974
ABST The report addresses current methods and future trends in forest renewal. Intensive forestry management and regeneration is discussed. Future predictions include improved utilization, loss of use of fire and herbicide, and containerized seedlings.
KEYW Cable system, economics, loblolly, machinery, silviculture

574 AUTH Zobel, B. J.
TITL Wood properties as affected by changes in the wood supply of Southern pines.
PUBL Tappi. 59(4): 126-128.
YEAR 1976
ABST The quality and type of wood available to the pulp industry is rapidly changing; manufacturers must plan ahead and learn to use the material becoming available. One of the main reasons why the wood supply of the future will differ from what it is today is that the wood available will be younger (more juvenile wood) because of reduced harvesting age and greater use of thinnings and top wood. This will result in wood with shorter tracheids having thinner cell walls, considerably higher hemicellulose content, and increased amounts of compression wood with its greater amount of lignin. Resin content will be lower and paper strength properties will be different from older wood within or among trees. Costs per ton of paper produced are expected to increase because of the low specific gravity and high moisture content of juvenile and top wood, and the small size of the timber with attendant high harvesting costs. Studies from one company indicated that the cost of producing one ton of pulp from 12-year-old thinnings was 65 percent higher than producing a ton from 30-year-old trees. Pulps from juvenile wood have high tensile strength, burst factor, folding endurance, and sheet smoothness, with lower tear factor and capacity than pulps made from mature wood. Under certain conditions, juvenile pine wood can serve as a partial substitute for hardwood and pulps for use in special products.
KEYW Juvenile wood, multiproduct, pulpwood, South, whole-tree

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Conversion Table

1 mm (millimeter) = 0.039 inch
1 cm (centimeter) = 0.39 inch
1 m (meter) = 3.28 feet
1 km (kilometer) = 0.62 mile
1 ha (hectare) = 2.47 acres
1 L (liter) = 0.26 US gallon
1 kg (kilogram) = 2.20 pounds
1 kPa (kilopascal) = 0.145 pounds per square inch (psi)
1 kW (kilowatt) = 1.34 horsepower
1 kN (kilonewton) = 0.2248 kips (1 kip = 1000 force lbs)

Stokes, Bryce J. 1992. An annotated bibliography of thinning literature. Gen. Tech. Rep. SO-91. New Orleans, LA: US Department of Agriculture, Forest Service, Southern Forest Experiment Station. 177 p.

This bibliography is a general review of thinning with an emphasis on harvesting in the southern United States. It was developed to aid the decision-making process of foresters and as a basis for continued research in thinning of pine stands.

Keywords: Feller-buncher, machinery, plantation, row thinning, selective thinning, silviculture.